NOVEMBER 1960

Power Engineering

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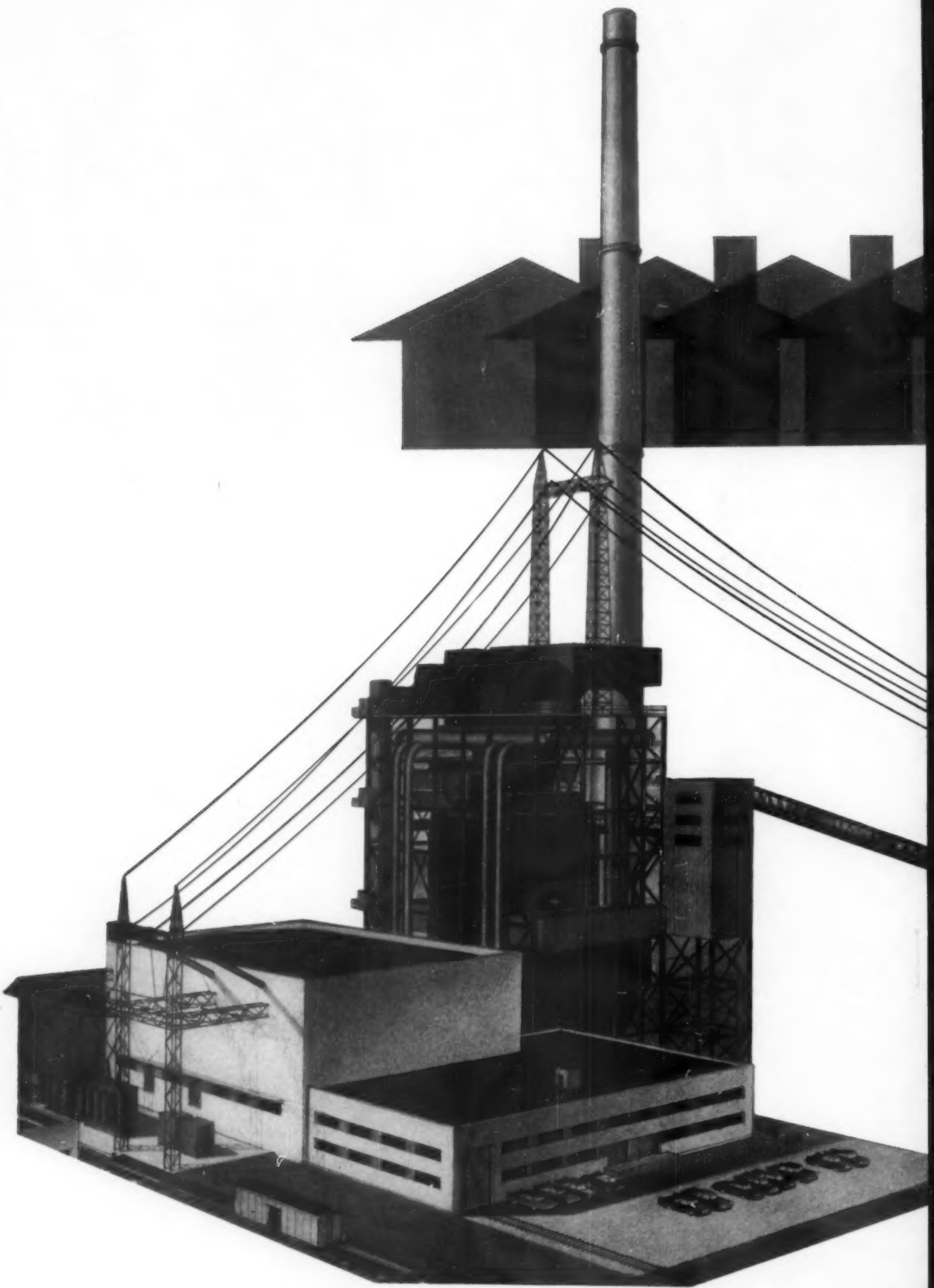

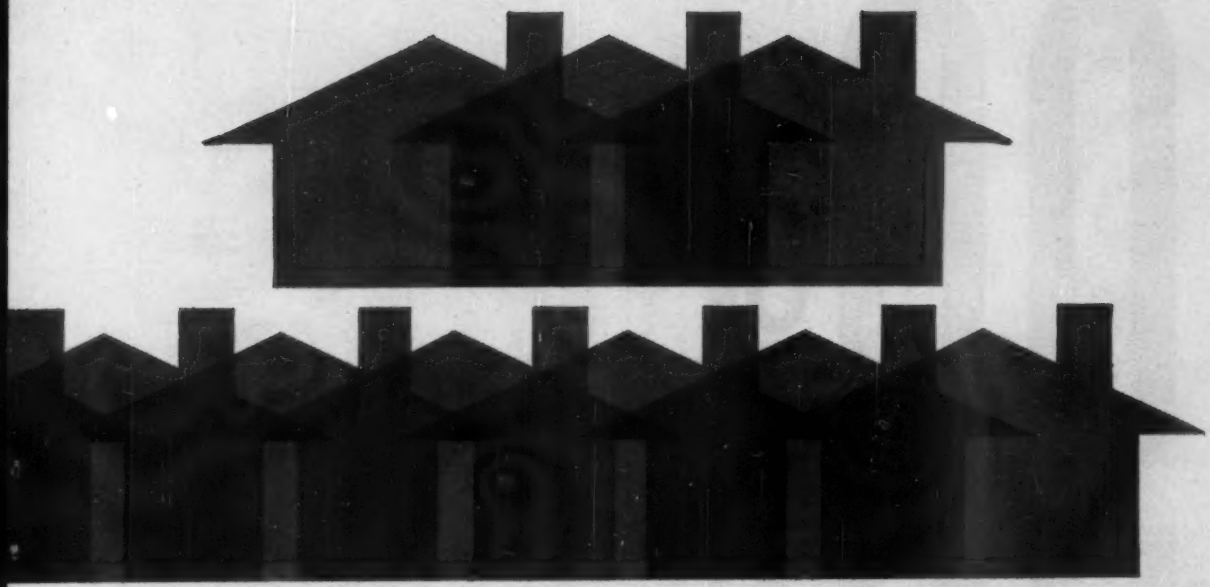

Electricity for an additional 130,000 homes ...without burning an extra ounce of coal!

The addition of two new Universal Pressure® Steam Generators —one now on-the-line at the American Electric Power System's Breed Plant, the other under construction at AEP's Philip Sporn Plant—marks a major milestone in the expansion of power utilities to meet America's surging demands for electricity.

Together, these units will provide steam at supercritical pressures (3500 psig at 1050 F/1050 F/1050 F) to generate about eight billion kilowatt hours of electricity annually. Each of these steam generators will consume a carload of coal every twenty minutes. Because of the improved cycle efficiency of these units, electricity generated from this fuel will be sufficient for the annual needs of over two million average American homes—130,000 more homes than could be supplied by burning the same amount of coal in the best generating stations now in operation in the world.

Net power of these stations is about twice that produced annually at Hoover Dam . . . yet cost of putting these new plants on stream (per kilowatt of electricity) will equal about 1/3 that of building a new Hoover Dam today.

Expansion is the measure of the future — and products of Babcock & Wilcox engineering and research will pace much of the nation and the utilities industry.

For more detailed information on the UP® Steam Generator and other B&W power generating systems and designs write: The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

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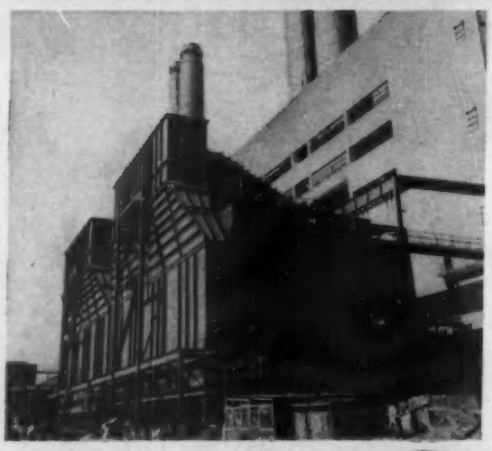
GUARANTEED FLY ASH REMOVAL

@ 2,800,000 cubic feet per minute*



** In addition to the Cottrell installations shown, Research-Cottrell has also completed or begun three more large 99% fly ash installations rated at 3,360,000 total cubic feet per minute. Two of these are repeat orders based on the excellent performance of those in service.*

Yes—99% is a rigid requirement. And it obviously requires the *best* in Cottrell precipitation equipment.

So—is there any wonder that Research-Cottrell is proud of the fact that they have fly ash precipitators in and operating in full compliance with this specification—also, that Research precipitators are *consistently* chosen for problems of this magnitude.

Research is the *only* company that can point to several large 99% fly ash installations. What's more—*repeat orders* give further proof of the high quality of the equipment and the high degree of performance of the Research precipitators.

So, for your own fly ash collection problem, doesn't it make good sense to place your confidence in the company and equipment with this proven performance?

Research-Cottrell

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Engineers' Preview

OF NEWS AND COMING EVENTS IN THE POWER FIELD

ANOTHER "world's largest" record was established on Sept 19, when the new 500,000-kw unit No. 7 at Widows Creek Steam Plant of TVA went into initial test operation. It has greater electrical capacity than all 18 units now operating in the Wilson Dam, TVA's largest hydro plant.

Under construction since March, 1958, the plant is located near Bridgeport in northeastern Alabama. (See News Reel, page 71 this issue.) Cost of the unit was $73,600,000.

Combustion Engineering, Inc built the twin-furnace pulverized coal-fired steam generator, which is rated 3,850,000 pounds per hour. General Electric Co supplied the 3600/1800-rpm single-reheat turbine-generator unit. Throttle conditions are 2400 psi 1050 F.

A second 500,000-kw unit will be built, which will bring the plant's total capability to 1,750,000 kw by 1963 and make Widows Creek the world's largest steam plant.

POWER SUPPLY COMMITTEE of the Mid-West Electric Consumers Assn is proposing a huge power coöperative plan which would comprise 1,250,000 kw of new generation, 470 miles of 345-kv line and 740 miles of 230-kv line in the 8-state eastern Missouri Basin area. Aim is to plan for meeting the needs of the municipal and rural electric coöperative systems in the 1965-75 decade when no additional Federal hydroelectric power will be available. Plan contemplates coöperative creation of a power grid that will compare with TVA, Bonneville, SPA and others in efficiency and performance. Cost would be an estimated $295 million.

FPC reports that electric energy production by electric utilities in the U. S. for the first half of 1960 was 369,632,934,000 kwh including 77,547,904,000 kwh by hydro plants and 292,085,030,000 kwh by fuel-burning stations. The six-month total registered a gain of 6.9 per cent, hydro production increased 12.1 per cent and fuel plant output 5.6 per cent over the like 1959 period.

Twelve months' production by electric utilities totaled 733,571,863,000 kwh for the year ending June 30, 1960. This total, the highest for any twelve-month period to date, exceeded by 0.3 per cent the previous maximum set during the period ending a month earlier, and was 7.9 per cent above the 679,997,982,000 kwh for the year ending June 30, 1959.

Combined utility and industrial power plant production for the year ending June 30, 1960 was 819,028,177,000 kwh, which was 7.0 per cent above the year ending June 30, 1959. Utility and industrial generating capacity totaled 179,687,885 kw on June 30, 1960.

EMERGENCY SERVICE to take care of possible power failures in homes of polio patients with respirators has been set up by Cleveland Electric Illuminating Co. Under the plan, such homes get immediate assistance in the event of a power interruption. Trouble section of the company is alerted at once, should the home of a polio patient be affected. The family is told that repairs are being made. Repair time is estimated, and if immediate power is needed to operate the respirator, the company sends a portable generator. Line crews give priority to restoration work in the patient's home area. This special service is available on a system-wide basis.

ALLIS-CHALMERS has purchased the controlling interest in a French firm which manufactures air-cooled diesel farm tractors, industrial engines, and engine-generator sets. Name of the French company is Etablissements de Constructions Mecaniques de Vendeuvre, S.A. It was established in 1837.

TO HELP ESTABLISH long-needed standards for clad metal tube sheet, Bridgeport Brass Co has submitted an engineering specification on copper and copper alloy clad steel plate for study by interested segments of industry. These products are of prime importance for corrosion control and high heat exchange efficiency in boilers, condensers, steam generators and similar heat transfer equipment. After industry acceptance, the proposal will be evaluated for acceptance by the ASTM, SAE and appropriate technical societies. For copies of the specification, write the company, at 30 Grand St, Bridgeport 2, Conn.

EUROPE'S most advanced nuclear research reactor and Austria's first has started operating at Seibersdorf near Vienna. Designed and built by American Machine & Foundry Co, the reactor is the heart of a new $6,000,000 nuclear research center

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built by the Austrian Study Group for Atomic Energy, a joint government-industry organization in which more than 60 Austrian companies are participating.

The AMF-built reactor is a light water-moderated, tank-type which will operate in the range of 5000 to 12,000 kw with provision to modify it later for substantially higher powered operation. It has several advanced features. One is direct access to one face of the core for large experiments, by use of a remotely-operated vehicle which can be driven through the reactor walls into the heart of the uranium core.

Also, for the first time, atomic scientists will be able to view their experiments directly during irradiation in the center of the reactor. The experimental equipment as well as the core is visible from both core level as well as from the top of the reactor.

LONG-TERM research program to advance fuel-cell technology has begun at Battelle Memorial Institute in Columbus, Ohio. The program is being underwritten by some 25 companies. Much of Battelle's research will be aimed at obtaining a better understanding of the properties of materials required in a fuel cell and developing materials which approach the ideal.

CONSULTING ENGINEERS COUNCIL, Springfield, Ill., representing state consulting engineers organizations nationally, has published a 16-page booklet titled You and Public Relations, for use by state groups, firms and individual engineers. Pamphlet was written to show how important good public relations are for the consulting engineer and how they can be attained.

SILICON RECTIFIER SYSTEM designed into a three-story building will furnish the power for Hooker Chemical Corp's new chlorine-caustic cell line plant at Niagara Falls, N. Y. Electric equipment totaling more than $1 million will be furnished by General Electric for the plant, which is scheduled for completion in the spring of 1961. The silicon rectifier system occupies less than half the ground space normally required for a system of this type. It will convert 60-cycle current to direct current for the operation of electrolytic cells to produce chlorine and caustic soda.

UNDER a $500,000 appropriation by Congress, the Public Health Service's Division of Water Supply and Pollution Control will begin a six-year anti-pollution study of the United States jurisdiction of the Great Lakes Basin-Illinois waterway. The $500,000 covers the first year of the project. The funds will be used to start intensive studies of the kinds and amounts of municipal and industrial wastes being discharged into the waterways within the metropolitan area of Chicago, and the pollutional effects of these wastes.

MAJOR STEP in the control of air pollution in the San Francisco Bay Area has been undertaken by the Bay Area Air Pollution Control District with the enactment of its Regulation 2. All operations which put forth air contaminants for incineration, heat transfer, general combustion, and other general operations were required to register with the District by September 1, 1960. Deadline for compliance with air pollution restrictions was set as January 1, 1961. Regulation 2 restrictions are designed to eliminate most gritty or flaky emissions, drastically reduce soiling particles, improve visibility, eliminate odors and vegetation damage.

AMERICAN INDUSTRY spent $8.2 billion on research and development in 1958, according to the National Science Foundation. This was a 7 per cent increase over the figure for 1957, and more than double the performance level of 1953. The aircraft and parts and the electrical equipment and communication industries accounted for more than half of the $8.2 billion total.

ALL-NEW edition of Mineral Facts and Problems, an encyclopedic reference on metals, nonmetals, and mineral fuels and the industries that produce them, has been published by the Bureau of Mines. The 1000-page volume is designated as Bulletin 585, can be purchased from the Superintendent of Documents, Washington, D. C., for $6 a copy.

U. S. DEPT OF THE INTERIOR plans to establish an Office of Coal Research to contract for research aimed at increasing the utilization and output of coal. The Department already has asked the Budget Bureau to approve a request for funds to finance the first year of coal research.

FEDERAL GRANTS totaling $180 million have been made to 2156 local communities to help build sewage treatment plants since the beginning of the Federal water pollution control program in 1956. Estimated cost of the sewage treatment plants and facilities during the four-year period was $1044 million.

Since the beginning of the program under Public Law 660, 1031 sewage treatment plants and facilities have been completed, at a total estimated cost of about $300 million. Projects now under construction total 682, at an estimated cost of about $320 million. During this period more than 21,000 miles of streams have been improved for drinking water, recreation, fish and wildlife, and industrial uses.

AMERICAN Society for Testing Materials has published its 1959 ASTM *Proceedings*, vol. 59. This 1424-page volume records the technical accomplishments of the year, including reports and papers, together with discussions. Copies of the *Proceedings* may be obtained at $12 each, from ASTM, 1916 Race Street, Philadelphia 3.

MARK YOUR CALENDAR: 24th National Power Show, ASME-sponsored, Nov 28–Dec 2, at the New York Coliseum.

National Conference on the Application of Electrical Insulation will hold its third annual meeting and exhibit in Chicago, Dec 5–8.

Seminar on industrial standardization, to be held in the Engineering Societies Building, New York City, Jan 23–27, by Dr. John Gaillard, 135 Old Palisade Rd, Fort Lee, N. J.

12th Western Metal Congress and Exposition will be sponsored by ASM at the Pan-Pacific Auditorium in Los Angeles, Mar 20–24, 1961.

ANACONDA CONDENSER AND HEAT EXCHANGER CLINIC

"Cupralum," lead-surfaced Anaconda copper tube, offers practical answers to some tough corrosion problems

If you'd be interested in more compact, more economical heat transfer units for handling corrosive liquors — sulfuric, chromic, phosphoric acids, sulfites, sulfates, alum, and the like — you should know about Cupralum*. Cupralum, a product of Knapp Mills, Inc., is Anaconda copper or copper-alloy tube to which a uniform, dense-structured, extruded chemical lead surfacing has been metallurgically bonded.

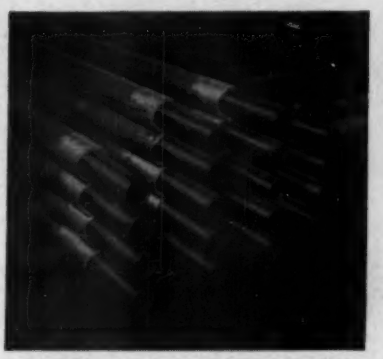
Alfred P. Knapp, chairman, Knapp Mills, Inc., explains to visitors how his company's patented drawing process metallurgically bonds lead surfacing to copper tube.

THE OUTSIDE lead surface, which may be from ⅛" to ½" thick, resists concentrations of acids—of sulfuric acid, for example, up to about 85% and up to 428 F. Being bonded to the copper, it expands and contracts with the copper during temperature cycling. Without the metallurgical bond, the lead would creep and eventually fail—an inherent weakness of all-lead tubing.

THE COPPER or copper-alloy tube inside provides strength to make Cupralum self-supporting — and to stand steam pressures up to 150 psi in standard wall thicknesses offered. It also provides its high corrosion resistance internally to cooling waters, steam, and refrigerants.

Most important, copper offers its high heat transfer rate. Because of the metallurgical bond with the lead, the over-all heat transfer rate of Cupralum is high—higher than all-lead tube and higher than that of iron and steel.

THE NET RESULT is that a given heat transfer job can be done with fewer square feet of surface — for a more compact unit. Or it is possible to get increased capacity in present existing space.



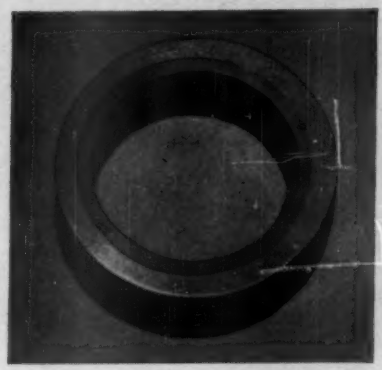
Lead surfacing removed from ends of Cupralum tubes preparatory to insertion in lead-clad steel tube sheet. Tube ends are usually rolled, but for severe thermal cycling service, may be brazed to outer steel face of tube sheet.

Two U-bend Cupralum tube bundles like this are used in a Ferrolum (lead-surfaced steel) separator tower to boil off ammonia from a urea carbonate ammonia solution—in the production of urea fertilizer. Anaconda copper tube core 1" O.D., 12 gauge, handles 150-lb. steam. Lead surface is ¾ inch thick. Separator tower operates at 145 C (293 F) and 240 psi.

In many cases, the first cost of the coil is lower. Usually this is true where higher steam pressures than those previously used are available—or where expensive, hard-to-fabricate alloys have been used. Improvement of the heating or cooling cycle is another source of savings. Under any circumstances, a long operating life and easy maintenance provide over-all economy.

NUCLEONIC APPLICATIONS. Cupralum with a thicker surfacing of lead is being used increasingly in the nuclear industry. For gamma shields that must be cooled, Cupralum coils are built in to provide efficient heat transfer from the shield to the cooling medium.

Where radioactive liquors and spent resin discharge from demineralizers must be conveyed through process piping into process vessels for concentrating the radioactive solution, Cupralum piping prevents the escape of gamma radiation. In nuclear applications, the lead surfacing may be 1" to 8" thick.



Cutaway section of Cupralum tube. It is produced in 20' lengths or in long continuous coils —from 40' to 100' depending on diameter. It is easy to bend and fabricate. Reliable jointing techniques have been developed.

Lead surfaces of Cupralum tubes and of tube sheet are fused by lead-to-lead welding. Then an extra thickness of lead is applied at the joint for extra protection.

FOR MORE INFORMATION. For detailed data on Cupralum, write Knapp Mills, Inc., Wilmington, Del. Or see your Anaconda representative, who can also provide data on the full line of Anaconda copper and copper-alloy tubes—arrange for technical assistance in meeting special corrosion and heat transfer problems. Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 60711

*Registered trademark of Knapp Mills, Inc.

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TUBES AND PLATES FOR CONDENSERS AND HEAT EXCHANGERS

Anaconda American Brass Company

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Tracers

COMMENT, OPINION, AND NEWS ABOUT PEOPLE

▶ In September, page 88, **Edward Switow** of the Louisville Gas and Electric Co wrote a brief description of how to use black light to locate leaking condenser tubes. Now comes this comment from **Thomas S. Warren,** president of Ultra-Violet Products, Inc:

> This is the first and most concise description of the proper procedure in the use of black light inspection that we have come across. Many companies have written to us on how to follow the procedure and we have always given them what information we could, but this puts it into a very clear, concise and readable form. I am sure that other people in the industry would appreciate having the article made more readily available to them.

▶ **Philip Sporn,** president of American Electric Power Co, comments on POWER ENGINEERING reports of the World Power Conference in Madrid and the CIGRE meeting in Paris (Aug and Sept issues):

> Giving complete critical accounts of such affairs as took place in those two cities this summer is a very difficult job. It is not only that it calls for attending many meetings, frequently sessions that are running in parallel, but compressing both account and critical comment in the brief space you have available is, independent of all other things, a difficult affair. Considering all these things, I think you did the job extremely well and I particularly liked your CIGRE account.

▶ **John M. Ferry,** special assistant for installations, Department of the Air Force, writes:

> I have just completed reading the article entitled Power Engineering is Big Business With Our Air Force, published in the September issue of POWER ENGINEERING.
>
> I want to thank you for the excellent presentation and reporting of this conference. It is factual, interesting and conveys an excellent sense of the meeting held at Wright-Patterson Air Force Base, Ohio.
>
> I particularly wish to express my appreciation for the editor's note at the end of the article (page 94) in which you compliment the Air Force power engineers on their efforts to do an economical job of heat and power production and utilization. . . . It is most gratifying to see evidence of public appreciation of the effort devoted to this sphere of activity in the Air Force.

▶ Thank you very much for the September issue of POWER ENGINEERING, writes **Russ Attridge** of Minneapolis-Honeywell's Federal Services Group:

> I think you did an excellent job of covering the Air Force (Heat-Power) Conference (page 68). Needless to say, your article has been very well received here in Washington by various Air Force Headquarters personnel. They are very proud of your Editor's Note.

▶ Future sources of power may be found in harnessing the steam produced by underground explosion of hydrogen bombs. So states **Glenn B. Warren,** vice-president of General Electric Co and consulting engineer for the Turbine Division. Such a plan for power was part of Operation Plowshare, a program for peaceful use of atomic bombs. Warren says:

> We would make a hole in the ground, 10,000 ft or so deep with a large cavern at the bottom, fill it up with water, and then drop a bomb into it, say every two or three weeks, and harness the steam that results from heat of the explosion.
>
> Harnessing of power by this explosion method of fusion might be quicker and easier than with the continuous fusion processes which are now being investigated and which might require containment of fantastically high pressures and temperatures.

Warren recently received the New York State Society of Professional Engineers' Engineer-of-the-Year award for 1960.

▶ New edition of the membership directory of the Association of Diesel Specialists has been released. Also a companion booklet, What Can The ADS Do For You, containing concise statements about the functions of the Association and the services members render in the industry. Free copies of both can be obtained by writing to **S. E. Franklin,** Diesel Control Corp, 226 N. Marine Ave, Wilmington, Cal. President of the Association is **H. B. Sirotek,** head of Illinois Auto Electric of Chicago.

▶ **Carroll F. Hardy,** associate director of the Marketing Dept of the National Coal Assn, has been elected a Fellow of ASME.

Ralph H. Tripp of Huntington, L. I., is the new president of the Instrument Society of America. Tripp is assistant director, Flight Test Div, Grumman Aircraft Engineering Corp.

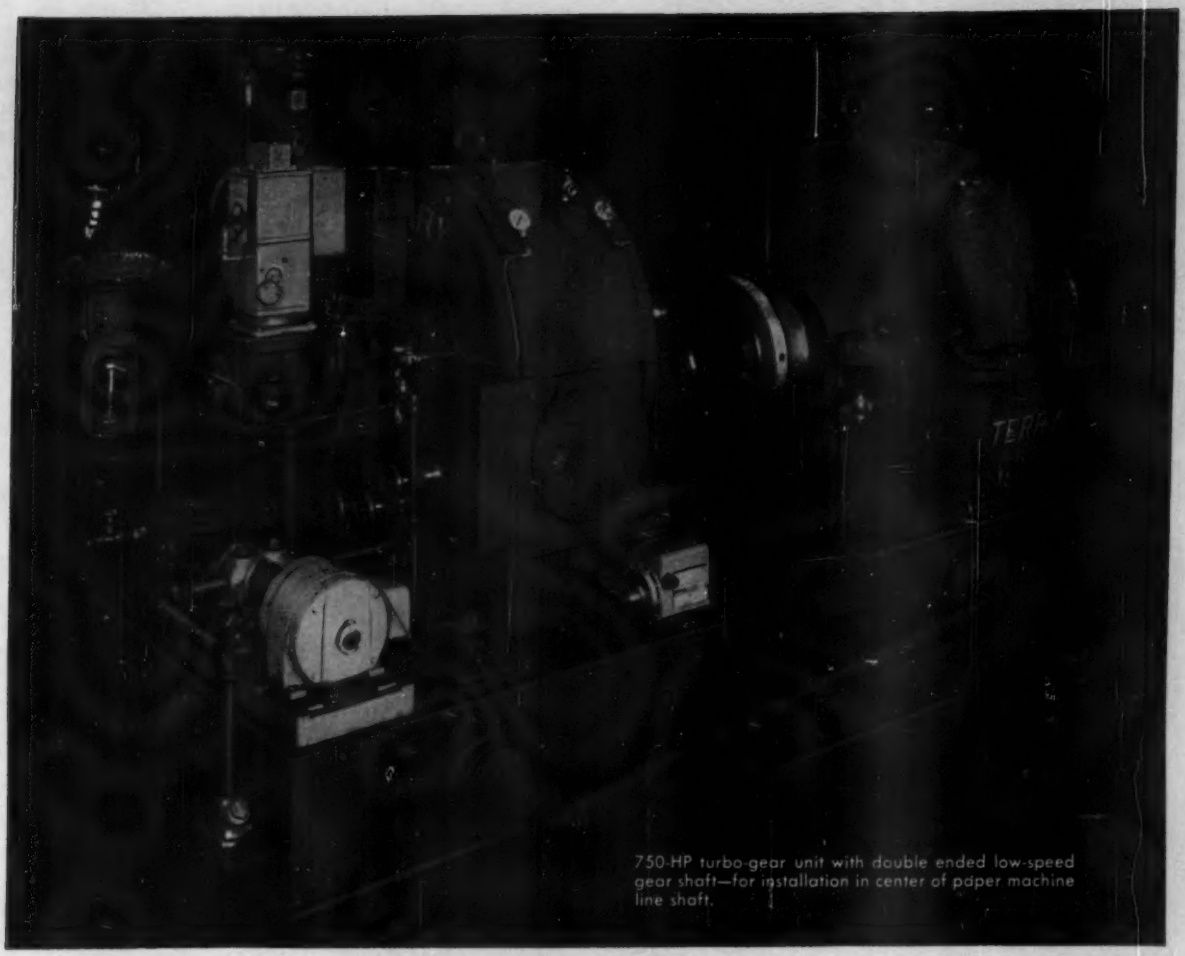
President for 1961 of the American Institute of Mining, Metallurgical and Petroleum Engineers is **Ronald R. McNaughton,** of Trail, British Columbia. McNaughton is manager of the Metallurgical Div of the Consolidated Mining and Smelting Co of Canada.

Selden B. Crary, system analysis engineer in General Electric Co's Electric Utility Engineering Section, has been awarded AIEE's William M. Habirshaw medal "for contributions to the stability, reliability and economy of bulk power transmission systems, and international leadership in the field."

Kenneth P. Locke has been named an assistant controller of the Detroit Edison Co.

Nelson D. Griswold, assistant general manager of the Texas Div of Dow Chemical Co, has been elected to the grade of Fellow in ASME.

E. S. Dulin has retired from Byron Jackson after 31 years of service with the company. He was president from 1929 to 1958, chairman of the board from 1945.



750-HP turbo-gear unit with double ended low-speed gear shaft—for installation in center of paper machine line shaft.

LOW-SPEED TURBINE DRIVES

tailored to meet your requirements

For more than half a century, Terry has been one of the principal suppliers of turbo-gear units for driving slow-speed fans, generators, paper machines, large pumps and the like. Each unit is designed to meet the job requirements. The paper-machine drive illustrated is a good example of this *individualized engineering.*

In service at a large southeastern paper mill, the unit delivers 750 HP at 3350/500 RPM, with steam conditions of 450 lbs., 660°F and 50 lbs. back pressure. Equipped with a variable-speed governor, operated by remote control, the speed of the unit may be varied through a 10:1 range. Other features include forced-feed lubrication to turbine and gear bearings, and automatic shutdown and alarm in case of low oil pressure.

Whatever *your* requirements for low-speed turbine drives, a Terry engineer will be pleased to discuss them with you. Bulletin S-140 covers the full line of Terry turbines; Terry gears are described in bulletin S-130.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

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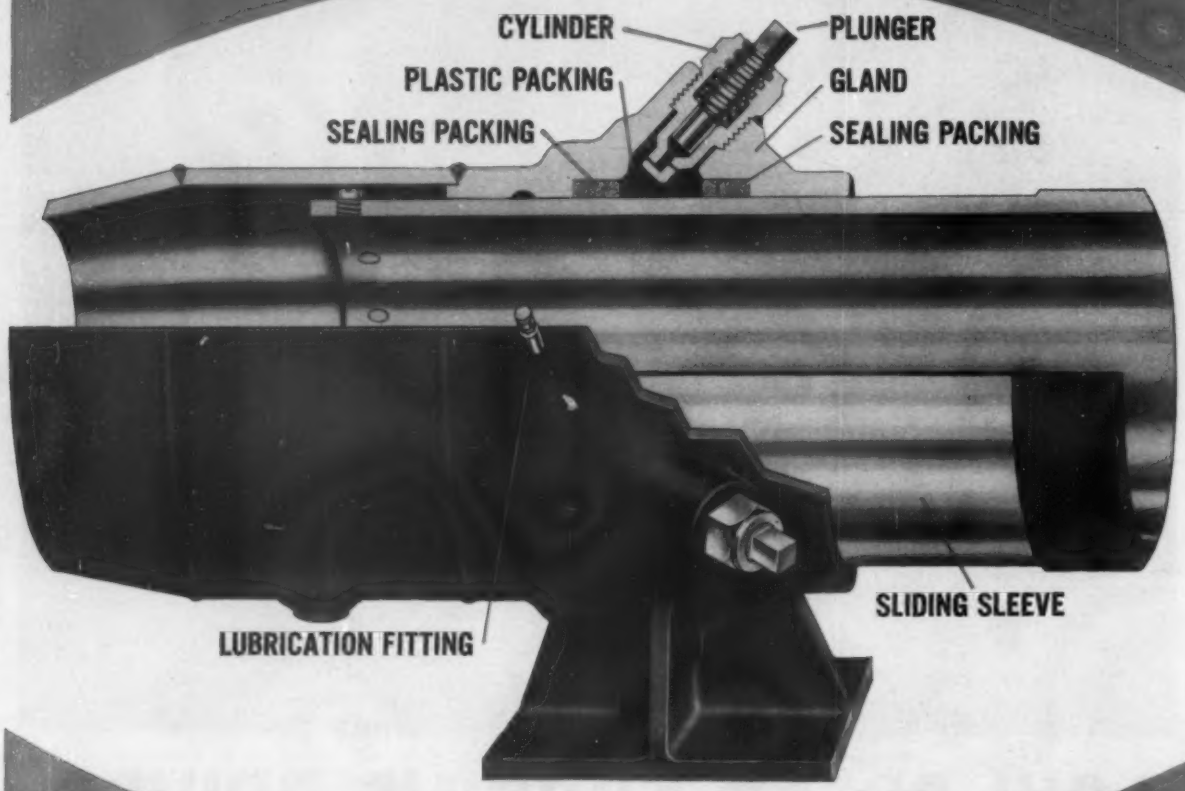
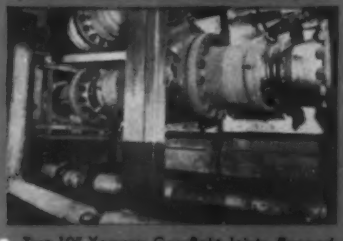
GIVE STEAM and HIGH TEMPERATURE



Only Yarway GUN-PAKT combines these outstanding features with design simplicity. GUN-PAKT Joints are available in single or double ends, welding or flanged, and in standard pipe sizes up to 30".

• 5 of 36 Yarway Gun-Pakt Joints, 2½" to 16" sizes, welding ends on steam lines at mid-west state institution.

• 6" Yarway Gun-Pakt Joint, flanged ends, on steam line at eastern industrial plant.



• Two 10" Yarway Gun-Pakt Joints, flanged ends, on return line of high temperature water system at New Jersey industrial plant.

• Group of 8" Yarway Gun-Pakt Joints, with automatic lubrication, on high temperature water lines at large international airport.

WATER LINES THESE BENEFITS...

✓ TROUBLE-FREE SERVICE
✓ LOW MAINTENANCE
✓ SIMPLIFIED DESIGN

WITH YARWAY GUN-PAKT EXPANSION JOINTS

Only Yarway GUN-PAKT Expansion Joints offer *simplicity*, *efficiency*, and *freedom from the "headaches"* that plague many plant engineers. That's why more engineers are specifying Yarway for efficient operation of steam and high temperature water piping in industrial plants, institutions and universities.

Yarway GUN-PAKT Expansion Joints offer you these advantages:

CONTINUOUS SERVICE—Shutdowns are eliminated. Addition of packing is seldom necessary, but may be added *under full line pressure.* No vents. Never needs repacking. *One plant lost, through forced shutdowns, production valued at $25,000. a day—until joints were replaced with Yarway* GUN-PAKT.

RUGGED DEPENDABILITY — All-steel construction with durable, chromium-plated, seamless steel sleeves. No chance of *metal fatigue.* Wrought steel bases provide rugged, positive anchorage.

INTERNAL AND EXTERNAL GUIDES—Positive alignment of sleeve in stuffing box—*where it counts.*

LIGHT WEIGHT, STREAMLINED DESIGN—Requires less space to install, less space to maintain, smaller manholes, fewer joints needed per length of pipeline.

MINIMUM MAINTENANCE—Many GUN-PAKT Joints have been *in service over 25 years with only nominal maintenance*—no major repairs or periodic overhauls. NEVER A SHUTDOWN FOR REPACKING. Maintenance records show an average of one manhour and 65 cents worth of packing needed per joint per year.

Why don't *you* investigate the advantages of GUN-PAKT Joints now? A Yarway engineer will be glad to discuss the subject with you. Invite him to call. Ask for Yarway Bulletin EJ-1917, too.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
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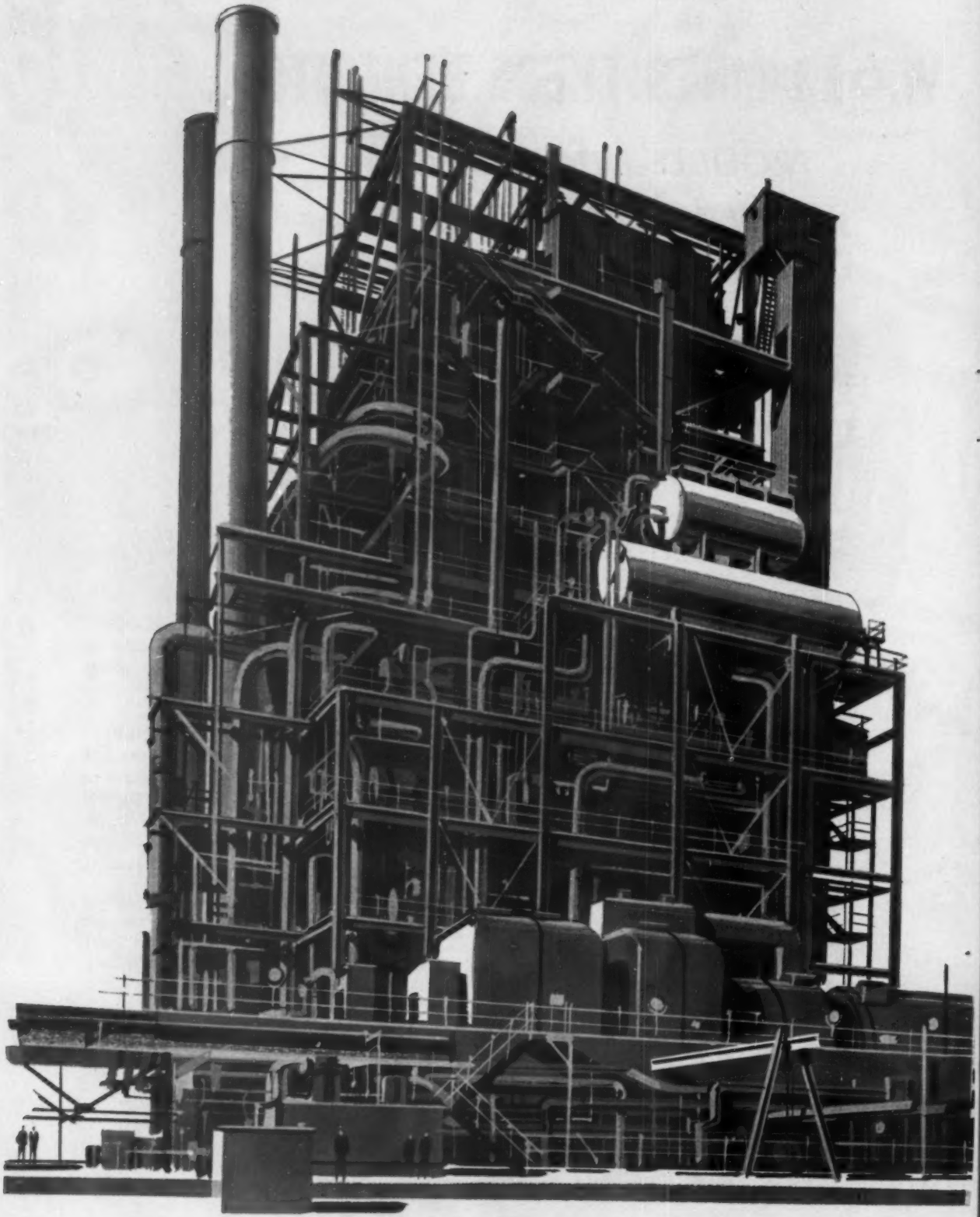

POWER PLANT PRODUCTS HEAT ENGINEERED BY FOSTER WHEELER:

Central Station and Industrial Steam Generators • Steam Condensers and Pumps • Cooling Towers

Pulverized Fuel Systems • Feedwater Heaters • Packaged Steam Generators • Nuclear Components

Why two (or more) heads are better than one

Janus, it is said, could look two ways at once.

If a manufacturer of power plant equipment had only one product to sell, of necessity his view would be limited.

Foster Wheeler has the advantage of being able to see the whole power plant picture because FW designs and builds not only complete steam generators, but also steam condensers, feedwater heaters, evaporators, cooling towers, pulverized fuel systems and nuclear components.

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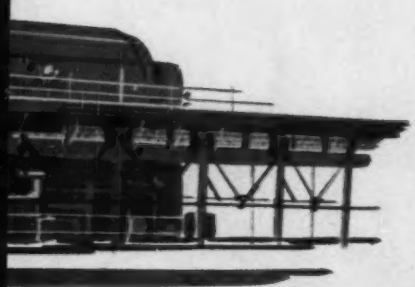

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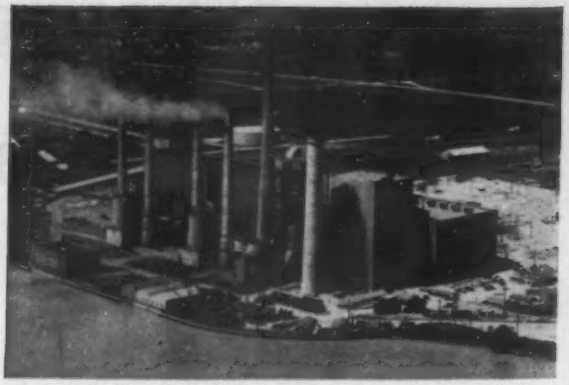
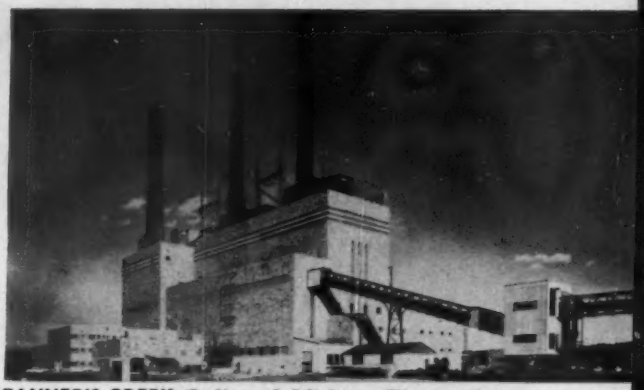
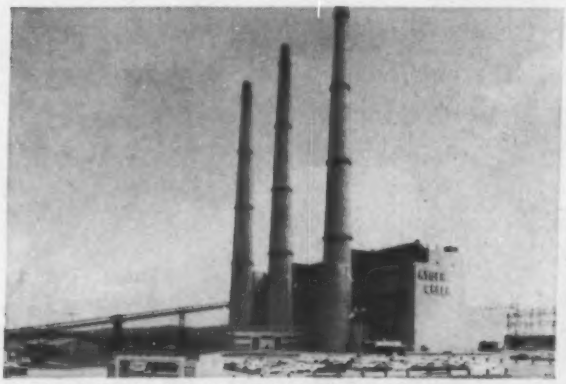


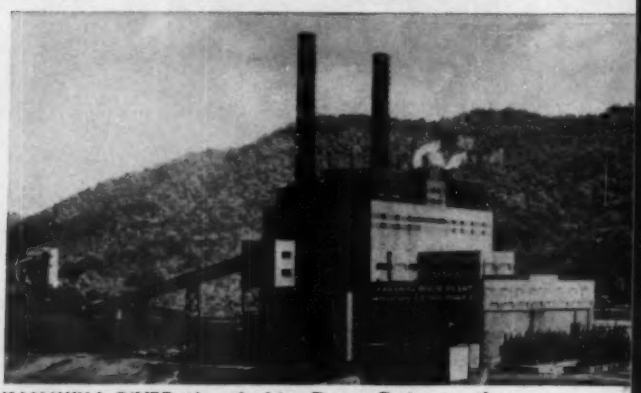
ST. CLAIR (The Detroit Edison Co.)—top 11, 1954-1958, averaging 9222 Btu/kwhr.



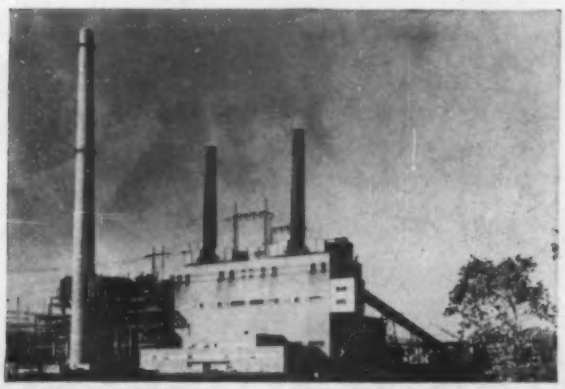
TANNER'S CREEK (Indiana & Michigan Electric Co.)—top nine, 1954-1958, first in 1956, averaging 9204 Btu/kwhr.



KYGER CREEK (Ohio Valley Electric Corp.)—top six, 1955-1958, first in 1955, averaging 9164 Btu/kwhr.



KANAWHA RIVER (Appalachian Power Co.)—top three, 1954-1958, first in 1954 and 1957, averaging 9128 Btu/kwhr.



MUSKINGUM RIVER (Ohio Power Company)—top five, 1954-1958, averaging 9216 Btu/kwhr.

BAY SHORE (The Toledo Edison Co.)—top ten, 1956-1958, averaging 9241 Btu/kwhr.

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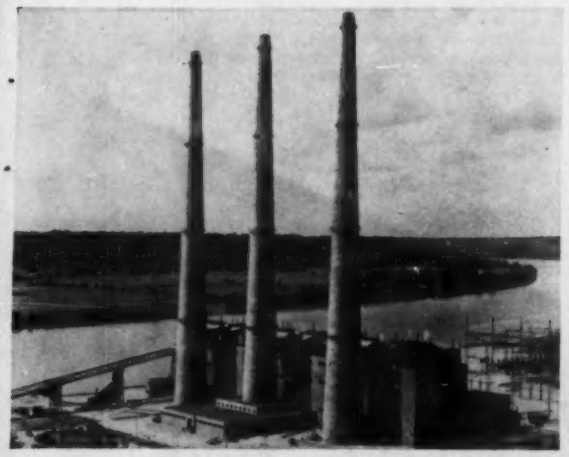
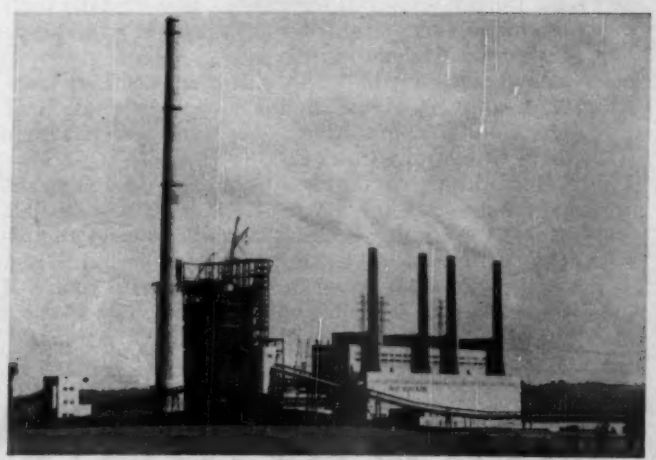


CLIFTY CREEK (Indiana-Kentucky Electric Corp.)—top five, 1955-1958, averaging 9155 Btu/kwhr.



PHILIP SPORN (Appalachian Power Co.—Ohio Power Co.) —top fifteen, 1954-1958, averaging 9378 Btu/kwhr.

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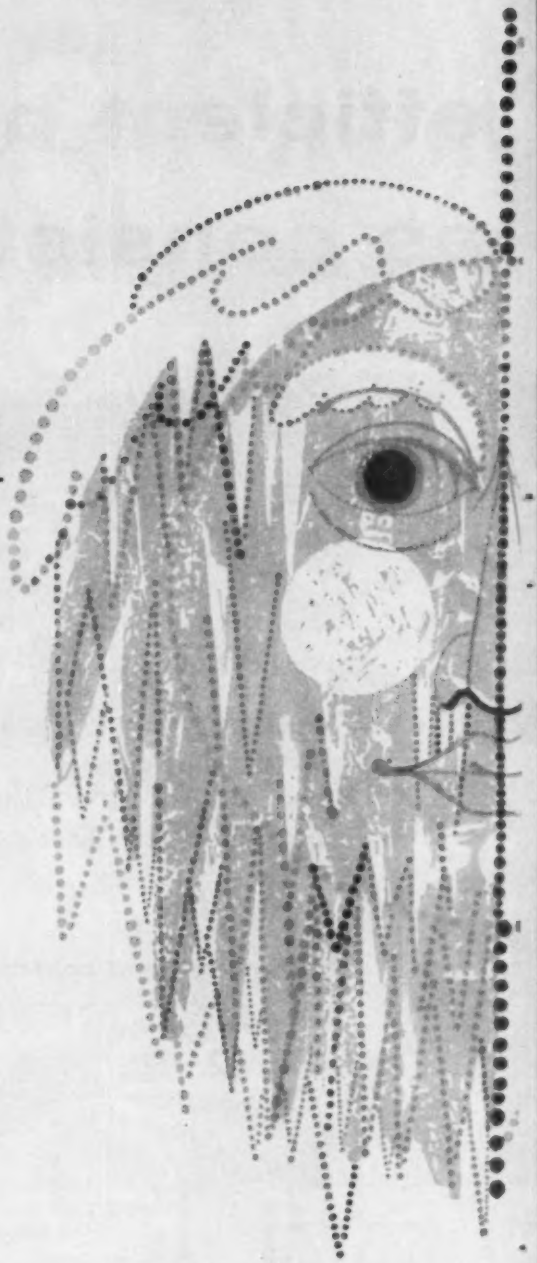

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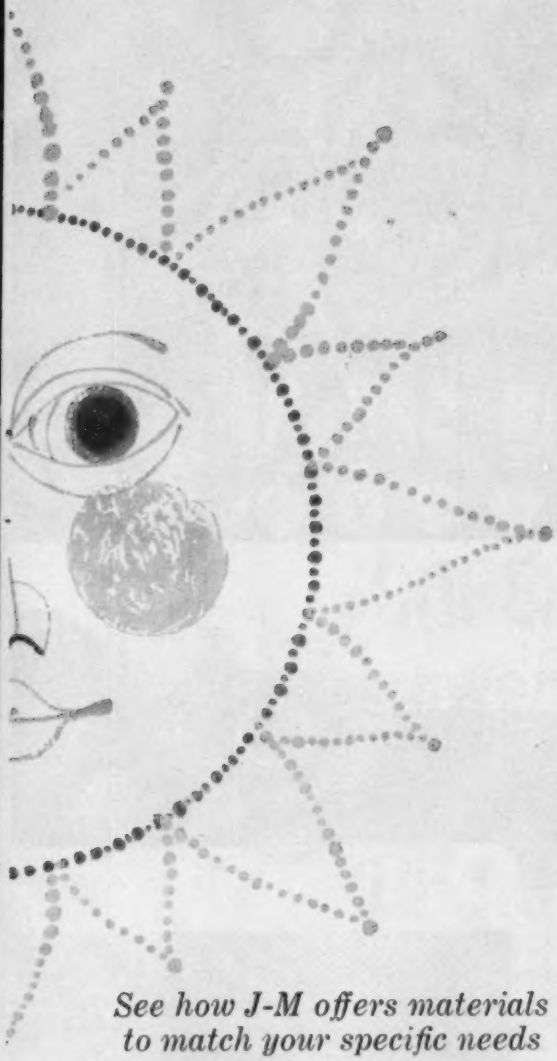

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J-M CEMENTS are designed for insulating or finishing applications. Eight types are made for general and special purpose use from such base materials as asbestos, magnesium carbonate, diatomaceous silica, mineral fiber, expanded vermiculite, hydraulic-setting cement, etc. Temperature limits range as high as 1900F.

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J-M INSULATING CEMENT can be applied by troweling in place . . . here, on a large cylindrical vessel previously covered with blanket insulation.

J-M WEATHERPROOFING JACKETS provide fire protection and weatherproofing as they meet any hot or cold insulating requirement. Most of the 12 available types are made of asbestos, felt-coated and saturated with asphalt.

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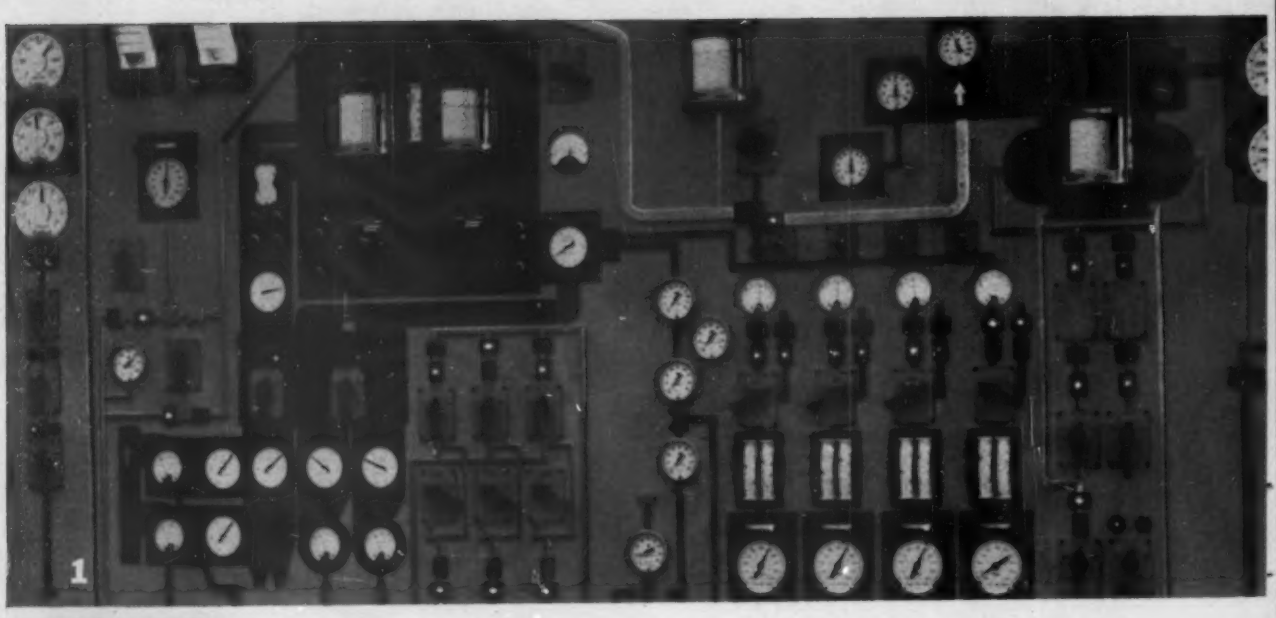
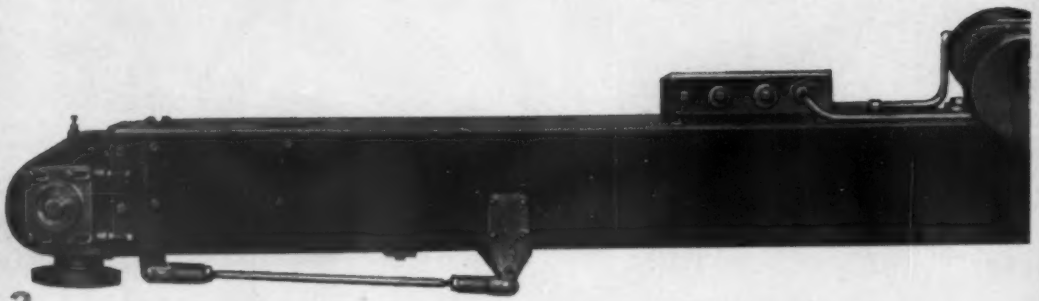
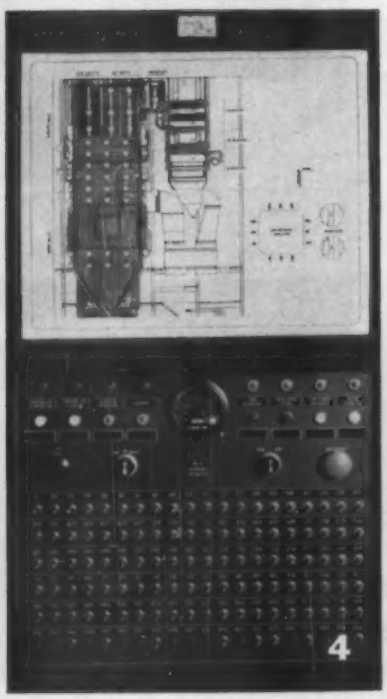
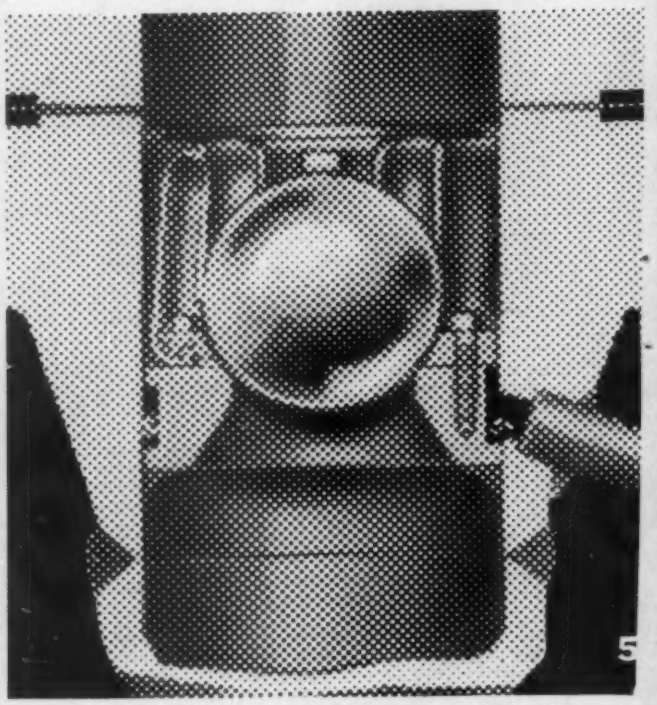
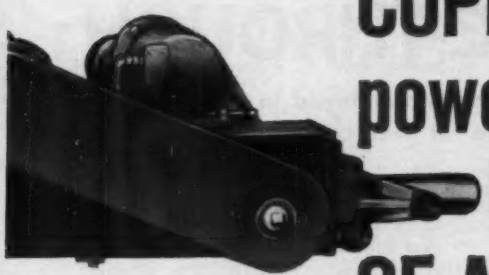


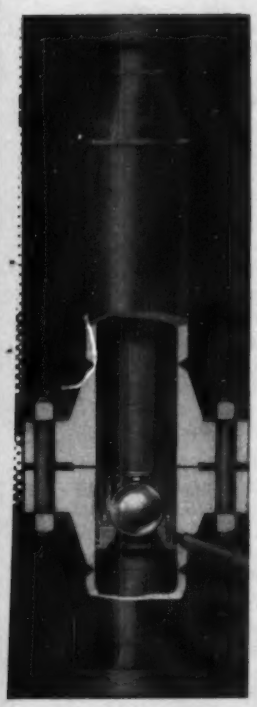








COPES-VULCAN increases power plant efficiency with NEW CONCEPTS OF AUTOMATIC CONTROLS



These are concepts of control from Copes-Vulcan. They range from **1** integrated boiler control systems that coordinate combustion, feedwater, boiler steam temperature, and boiler cleaning . . . to **2** a dual motor design that gives long retractable soot blowers their remarkable double helix cleaning pattern . . . to **3** unique liquid-sodium flow controls engineered and built to meet the industry's most challenging requirements . . . to **4** Selective-Sequence remote control for efficient programming of automatic boiler cleaning . . . to **5** greater accuracy in desuperheating control through an exclusive, Variable-Orifice design. Concepts of control, such as these, have increased efficiency in conventional, super-critical, and nuclear power plants on land and sea. To put this ingenuity to work for you on your next power project, write Copes-Vulcan Division in Erie, Pennsylvania.

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HELPFUL WATER CONDITIONING DATA FROM BETZ

HOW TO TREAT ONCE-THROUGH

Here is a review of the water treatment problems encountered in once-through cooling water systems—and the means available for their correction.

THE TERM "COOLING WATER" is applied wherever water is circulated through equipment to absorb and carry away heat. Cooling water systems can be classified as closed, open recirculating or once-through. The once-through system, as the name implies, is one in which the water is passed through the heat exchange equipment to absorb heat and then is discharged directly to waste or is used for some other purpose. The usual source of once-through cooling water is from wells, rivers and lakes where the cost involved is that of pumping only.

In a once-through cooling system no evaporation takes place and consequently the water does not concentrate. Therefore, the water characteristics remain substantially unchanged.

Generally, the once-through cooling system is favored because of its simplicity, lower capital investment, and lower operating costs when compared to the more complex open recirculating system. This is true where water of a suitably low temperature is readily available in large volume and at a low cost—*providing the quality of the water is also satisfactory*. Too often, scale formation, iron deposits, slime accumulation and corrosion lead to inefficient operation and require frequent cleaning, high maintenance costs and equipment replacement when water of poor quality is used. As a result, operating costs far exceed those anticipated and the "simplicity" of the once-through cooling system can disappear.

Scale Formation

Calcium carbonate is usually the chief ingredient of scale formed in once-through cooling systems. It is possible to predict from the water characteristics whether a water will produce calcium carbonate deposits for the operating conditions imposed. The physical factors that primarily influence scale formation are temperature, heat transfer and velocity. The chemical factors are calcium, alkalinity, pH and dissolved solids. By calculating the saturation index and the stability index of the water it is possible to predict with a high degree of accuracy whether calcium carbonate deposits will form and produce operating difficulties.

The most common method employed to inhibit calcium carbonate scale formation in once-through cooling systems is the use of various anti-nucleating agents that possess the property of preventing crystal growth and thereby prevent scale formation. The materials most commonly employed for this purpose include the polyphosphates, tannins, lignins and polyacrylates. Specific blends of these materials make it possible to secure the added benefits of each in preventing scale formation. Treatment levels generally range between 3 and 30 ppm depending on the degree of over-saturation with respect to calcium carbonate and the severity of the operating conditions imposed.

Figure 1—Typical iron deposition in pipe line.

Iron Deposits

A special case of scale formation may be encountered in once-through cooling water systems that employ well waters containing iron. The iron content of well waters varies widely and has been noted to range between 0.3 and 30 ppm. The iron found in well waters usually exists as ferrous bicarbonate which is unstable and will undergo decomposition to form ferrous oxide at points of heat transfer.

In addition to heat, oxygen and other oxidizing agents (such as chlorine) will hasten the decomposition of ferrous bicarbonate. Iron bearing well waters commonly contain iron bacteria which utilize iron in their life cycle. Well waters containing high amounts of iron and iron bacteria will produce rapid plugging of pipelines as illustrated by Figure 1.

Efficient treatments are available that will complex the iron and prevent precipitation. While the polyphosphates are capable of complexing iron, organic complexing agents such as citrates[1] and lignosulphonates[2] are considerably more effective. Blends of these materials have been used successfully in treating industrial cooling waters containing as high as 30 ppm of iron.

When iron bacteria are present it usually is necessary to control iron bacteria by a supplementary treatment. Generally, chlorination is not used because it hastens precipitation of the iron and detracts from the efficiency of the iron retention treatments. Special organic toxicants have been developed which effectively control iron bacteria and are compatible with the iron retention treatments.

Slime Formation

Biological fouling of heat exchangers is encountered frequently in once-through cooling systems that utilize polluted surface supplies. Less frequently, well waters are encountered that contain a high bacteria count that will produce slime formation. Slime formation will seriously interfere with heat transfer and in addition will accelerate corrosion. In most instances chlorination on a continuous or intermittent basis will serve to control slime effectively. As pointed out previously, however, chlorine rarely is the best recommendation when ferrous bicarbonate is a problem.

Corrosion

Corrosion in once-through cooling systems probably is the most costly of the difficulties encountered. Replacement of expensive equipment, pipelines and the loss of production are the end result. In once-through cooling systems, the principal factors influencing corrosion are

(1) Covered by U.S. Patent 2,529,177.
(2) Covered by U.S. Patent 2,744,866.
(3) Dianodic is a Betz trade name. The methods are covered by U.S. Patents 2,711,391; 2,900,222; 2,872,281; 2,848,299.

the water characteristics, temperature, velocity, and contact of dissimilar metals. The chief variables controlling the corrosion characteristics of the water are its dissolved oxygen content and carbon dioxide concentration. Occasionally, other factors are involved such as the presence of free mineral acid or hydrogen sulfide.

Particularly where *surface supplies* are used such as rivers, streams and lakes, the major cause for corrosion is dissolved oxygen. Figure 2, shows the effect of oxygen concentrations on the corrosion of low carbon steel at different temperatures. Philadelphia tap water was used in these tests, with a pH of 6.7 and a flow rate of 2.5 feet per second. Elimination of dissolved oxygen will effectively control corrosion. Vacuum deaeration has been successfully applied to once-through cooling systems for oxygen removal, but this method entails a considerable investment cost as well as

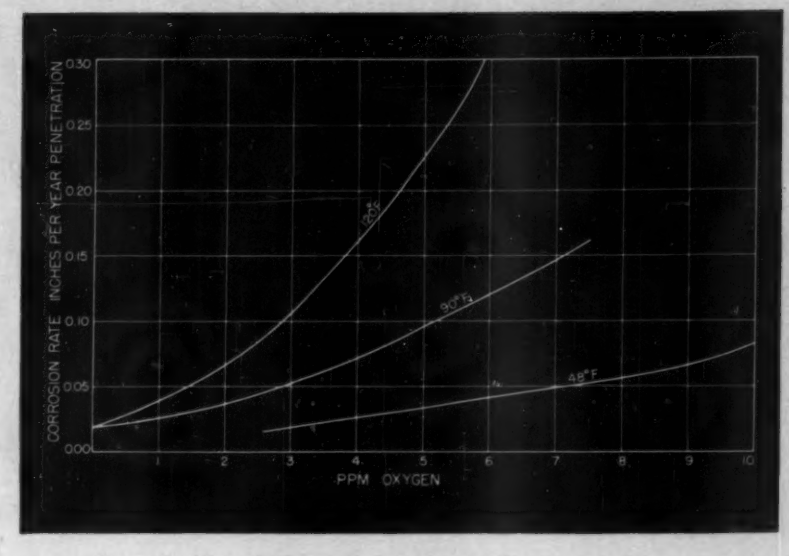

Figure 2—Effect of oxygen concentration at different temperatures.

COOLING SYSTEMS

a continued operating cost. Chemical deaeration also has been applied successfully and involves reacting the dissolved oxygen with catalyzed sodium sulfite. Chemical treatment costs with this method are approximately $1.00 per million pounds of water per part of dissolved oxygen. While waters low in dissolved oxygen can be economically treated, when the dissolved oxygen content exceeds approximately 3 ppm other chemical treatment methods usually will prove more economical.

Waters that contain appreciable amounts of oxygen can be treated more economically by inhibitors that form films or barriers which stifle the corrosion reactions. The Zinc-Dianodic methods,[3] which utilize combinations of polyphosphate, chromate and zinc inhibitors are particularly effective since they function by stifling both the anodic and cathodic corrosion reactions. The Zinc-Dianodic treatments are capable of rapidly forming a continuous, impervious film that will effectively passivate the metal surfaces and stifle the corrosion reaction. The rate at which the initial film forms is dependent upon treatment concentrations. Accordingly, the principles of pretreatment should be followed to establish the protective film rapidly. Once the film is formed, normal treatment levels, on the order of 10 to 20 ppm, will effectively maintain the film and prevent corrosion.

Well waters generally are devoid of dissolved oxygen and when carbon dioxide concentrations are low and hydrogen sulfide is absent, the corrosion rate will be negligible. However, frequently well waters do contain high concentrations of carbon dioxide on the order of 25 ppm or greater. Even in the absence of dissolved oxygen, excessive corrosion will take place not only of ferrous metals . . . but also of copper and its alloys. In these instances neutralization of the carbon dioxide either partially or totally will be required to prevent corrosion. When this corrective method is followed it is essential that the saturation and stability indices of the water be recalculated since the water may be rendered scale forming with respect to calcium carbonate and a supplemental treatment with an anti-nucleating agent may be necessary.

The most difficult of corrosion problems occurs when hydrogen sulfide is encountered. Hydrogen sulfide may be present in a water supply due to purely chemical or purely biological causes. The presence of hydrogen sulfide is more common in well waters than surface waters. Wells located in Boulder clay areas or "sour gas" fields frequently contain hydrogen sulfide. The presence of sulfate reducing bacteria may also be responsible for producing hydrogen sulfide. Generally, heavy chlorination of the water is required to consume the hydrogen sulfide. However, the proper treatment method will be contingent upon whether ferrous bicarbonate is also present, as frequently is the case.

It is essential when considering the use of a once-through cooling system that the quality of the water be investigated thoroughly from the standpoint of its potential for scale formation, iron deposits, slime accumulations and corrosion. The treatment methods for control of these problems have been well established by Betz. If you are investigating the use of a new water supply or are having problems with an existing water supply, why not call in a Betz engineer for a helpful discussion?

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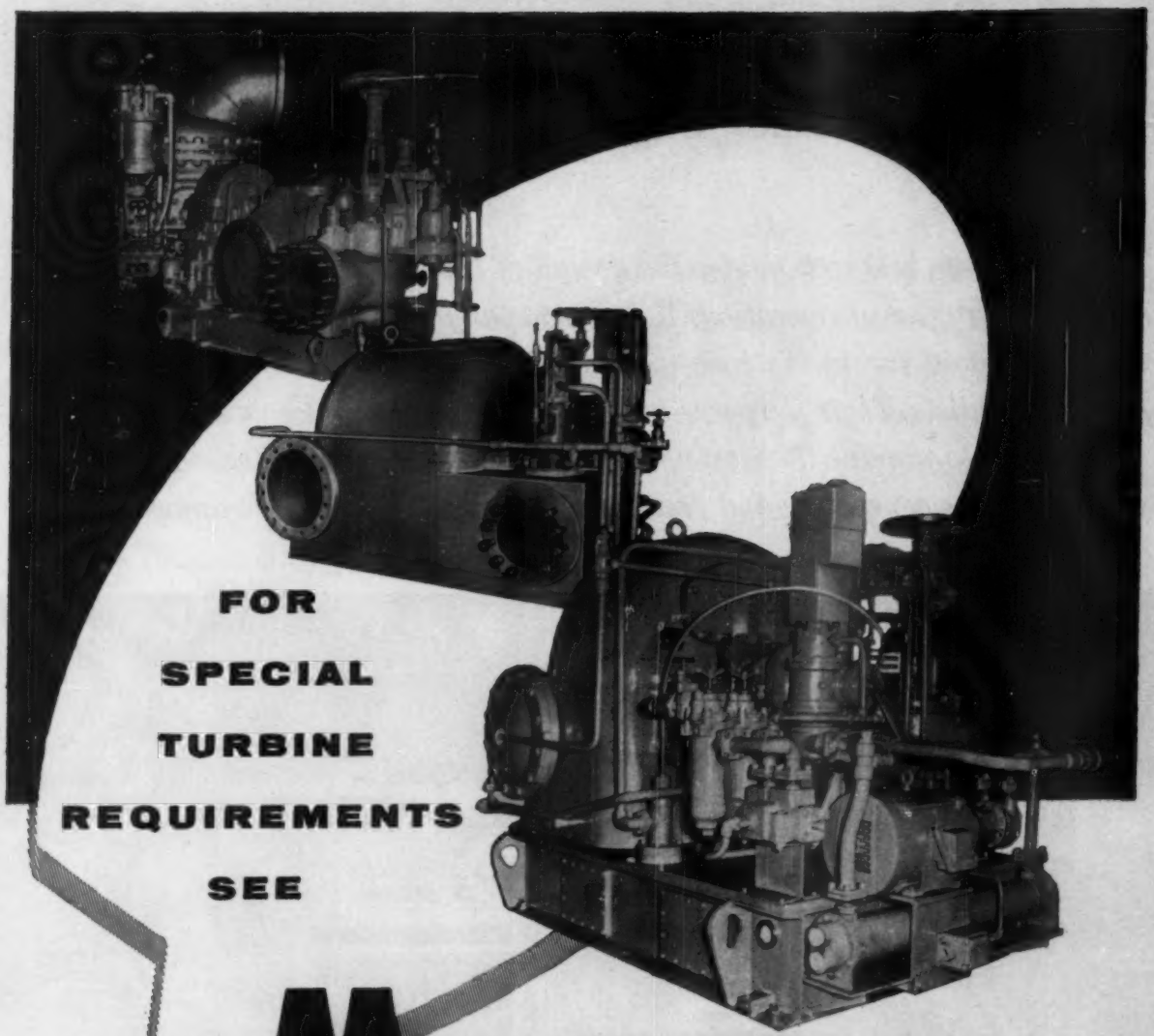

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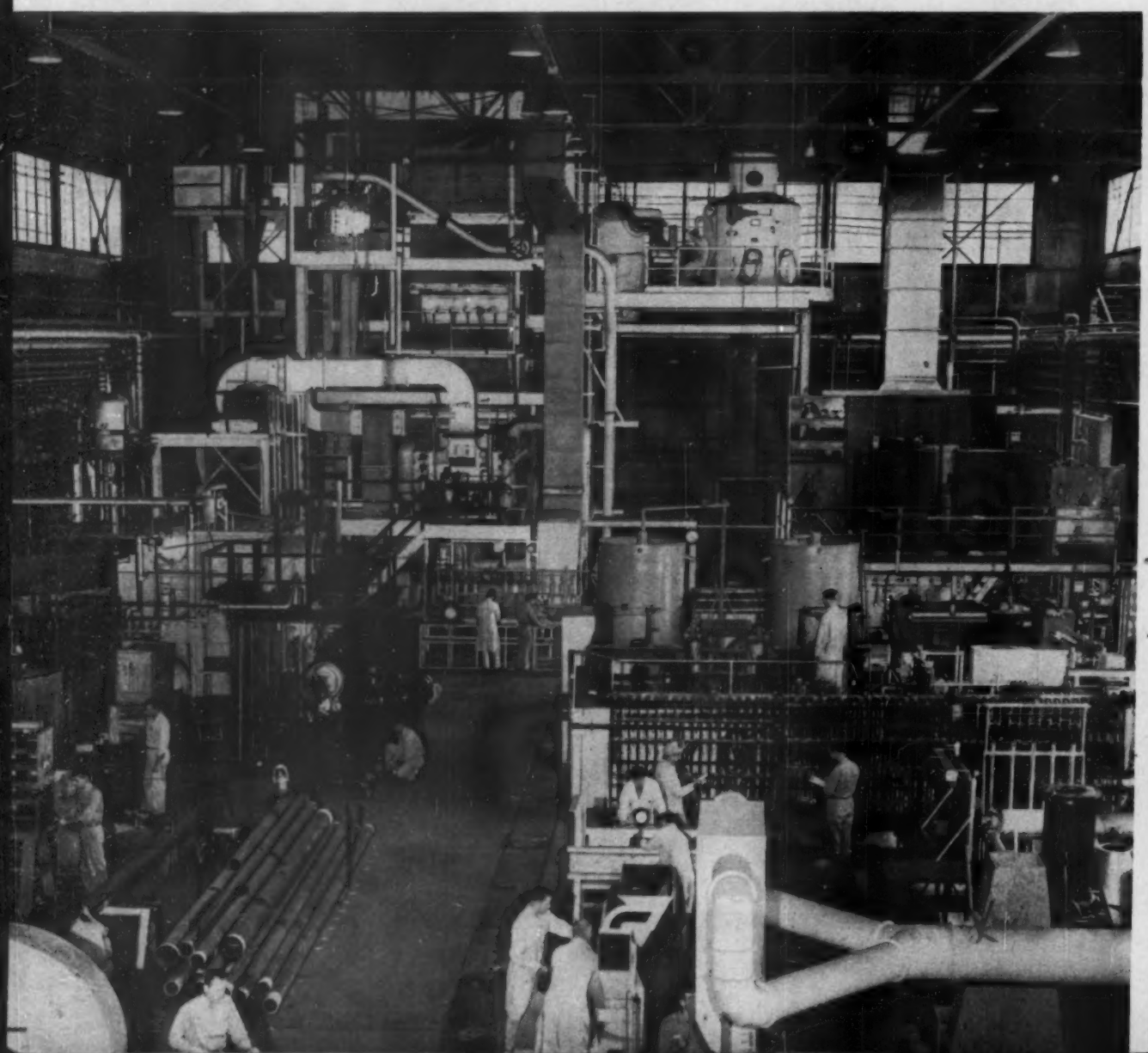

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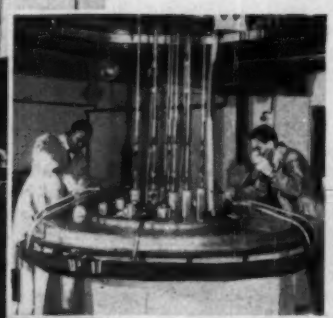
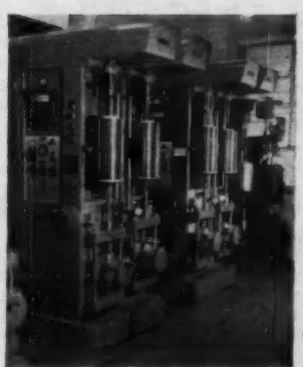
Research activities at C-E range from studies of the nuclear characteristics of the atom and the combustion of fossil fuels to the development of methods and materials, the test of metals and the operation of test boilers and nuclear reactor systems. Research, knowledgeable and in depth, is your assurance that C-E products are thoroughly engineered, are dependable and are as modern as tomorrow.

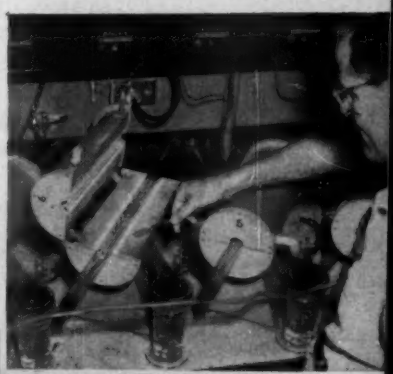
THE KREISINGER DEVELOPMENT LABORATORY is used for the study of fuels and fuel burning systems, water, steam and combustion gases. It contains several test boilers, among them a large Controlled Circulation unit capable of operating at 2000 pounds pressure and a super-critical pressure boiler designed to produce steam at 5000 pounds pressure and 1200°F. This laboratory is one of eight C-E research facilities which, together, total more than four acres under roof.



THIS ADVANCED CRITICAL FACILITY is one of two zero power nuclear reactors used by Combustion for test and experimentation.



THIS METALLURGY LABORATORY tests material strength at high temperatures with these creep-rupture machines.



THIS CHEMISTRY LABORATORY uses a battery of test furnaces to study the causes and effects of corrosive substances in combustion gases.

THIS PHOTOELASTIC LABORATORY makes plastic models of various kinds of pressure vessels and loads them to simulate actual operating conditions. Using straining frames and polariscopes, it analyzes the stress patterns locked in the plastic to determine suitability of design.

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Answers Questions about Steam Condensate Systems Corrosion . . . and How to Control It

Costs of Equipment Repair and Replacement Can Be Cut Drastically with a Sound Control Program

Industry still pays a huge annual bill for down-time, equipment replacement and repairs made necessary by steam condensate corrosion. Much of this cost can be eliminated by knowledge of what the problem is and action toward solving it. Here are answers to some basic questions that may be helpful to you.

Question: What does corrosion do in a steam condensate system?

Answer: Corrosion literally eats up the metal in the system from the inside. Piping, valves, pumps, and process equipment can be seriously damaged or ruined by corrosive condensate. Even boilers can be damaged by deposits resulting from metal oxides in corrosive returned condensate.

Question: What causes steam condensate corrosion?

Answer: Most condensate system corrosion is caused by carbon dioxide and oxygen, carried into the system with the steam. Carbon dioxide, dissolved in the pure condensed steam, forms corrosive carbonic acid. If oxygen is present with carbon dioxide, the corrosion rate is much higher, and is likely to produce localized pitting. Ammonia, in combination with carbon dioxide or oxygen, attacks copper alloys.

Question: What constitutes a corrosion prevention program?

Answer: There are three factors which should be examined in setting up a condensate corrosion-prevention program:

a. Softening, or other pretreatment of boiler feedwater should be designed to reduce the quantity of potential carbon dioxide that can be released from the boiler. Effective deaeration of feedwater also helps reduce oxygen content. Attention to both of these will make the final condensate corrosion prevention treatment more economical.

b. Mechanical design of the system should include such factors as maximum venting of corrosive gases, adequate velocities in lines, proper installation and maintenance of traps, and elimination of severe steam-impingement.

c. An effective chemical treatment program should be set up. Treatment may be either with a volatile amine chemical to neutralize carbon dioxide, or with a filming inhibitor which forms a protective barrier between the metal and the corrosive condensate.

Another important part of the chemical treatment program is continuous application of a fast acting chemical oxygen scavenger to the boiler feedwater.

Question: Can Nalco provide recommendations for a complete condensate control program?

Answer: Yes. Nalco will make a thorough survey and make recommendations for a complete corrosion control program.

Question: Which type of chemical treatment is best: volatile neutralizing amine or filming inhibitor?

Answer: This depends on the system to be treated. Plant layout and operating conditions, and the characteristics of boiler feedwater are some of the factors which should be taken into consideration. Generally,

James M. Seamon, Manager
Nalco Power Industry Chemicals Department

volatile amines are most desirable where low make-up volume, low feedwater alkalinity and good oxygen control exist. Filming inhibitors usually provide most economical protection in systems with high make-up, oxygen in-leakage, high alkalinity, or where the system is operated intermittently. In some plants, a combination of protective chemicals may be needed.

This is the area where Nalco know-how can result in thorough protection at minimum cost, by recommending a specific program to fit individual plant conditions.

Question: Isn't one condensate corrosion control chemical about the same as any other?

Answer: Definitely not. Both the volatile amines and filming inhibitors are complex chemicals—members of chemical "families" in which a nearly infinite variety of types is possible. Best treatment chemicals are those which offer the greatest protection in relation to their cost. Even though Nalco chemicals are now outstanding in results-per-dollar, Nalco research and development continues in order to improve this ratio.

Question: What help can Nalco provide in setting up and maintaining a condensate corrosion control program?

Answer: Your Nalco Representative has the technical training and experience to be of substantial assistance in setting up and maintaining an effective condensate corrosion control program. His service is backed by the facilities and experience of the entire Nalco organization. Where special problems occur, Nalco specialists are ready to help him find answers promptly.

Suggestion: Call your Nalco Representative, or write to me for further details on Nalco steam condensate corrosion control . . . or data on any aspect of modern water treating practices for better plant operating efficiency. James M. Seamon, Manager, Power Industry Chemicals Department.

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Current Catalogs

Electrical

101 Motor Selection Guide — This pocket-size card (GED-3909A) provides quick reference to frame size (182 to 445U) and book price for General Electric Co.'s a-c motors from ¾ to 125 hp. Data are tabulated for both drip-proof and totally enclosed fan-cooled Tri-Clad '55 squirrel cage, horizontal motors.

102 Synchronous Motors — Four new types of Slo-Syn motors are presented by the Superior Electric Co. in this 6-pp bulletin, including types for general and heavy-duty application, an explosion proof model and one designed to meet applicable military specifications regarding materials vibration. Instant starting, stopping and reversing, adaptability as stepping motor, and other advantages are discussed; dimensions given.

103 Pump Motors — This 34-pp brochure of U. S. Electrical Motors Inc. consists of a collection of technical articles on pump motors, illustrated with charts, diagrams, graphs, tables, and cutaways. Subjects range from turbine pump motor lubricants, pump motor bearings, to pumping stations and sound control, and steps in submersible installations.

104 Substation Transformers — Detailed information on I-T-E Circuit Breaker Co.'s liquid-filled substation transformers, single- and three phase, 501 to 10,000 kva and up to 69 kv, is presented in 16-pp Bulletin 5800-1A. Dimensions for single and three-phase oil immersed transformers and specifications included.

105 Frame Mounted Breakers — Bulletin 7213, 16 pp, describes AF frame mounted oil circuit breakers of Federal Pacific Electric Co. Breakers have ratings of 23, 34.5, 46 and 69 kv ASA and NEMA standard. Bulletin describes all components. Dimensions of the breakers are shown in tables and in schematic drawings. Also provided is information on maintenance and transportation.

106 Electric Motor Controls — Pocket Catalog 60, published by Furnas Electric Co., 56-pp, gives descriptions, ratings, prices for manual and magnetic starters, drum controller, pressure, foot and limit switches. Included are push buttons, related pilot devices, motor rating, heater coil data, and selection tables.

107 Stored Energy Switchgear — Features and advantages of I-T-E Circuit Breaker Co. stored energy metal-clad switchgear are detailed in 20-pp Bulletin 2801-2A. Panel layout and dimensions are illustrated and ratings tabulated.

108 Compact Capacitors — Illustrated and described by General Electric Co. in 16-pp Bulletin GEA-7061 is a line of compact capacitors and pole-type equipments. Advantages are detailed, and unit ratings, weights, dimensions and group fusing data included.

109 Electric Utility Bus Duct — Application data for electric utility bus duct is contained in 12-pp Application Data 30-664, issued by Westinghouse Electric Corp. Descriptions, drawings, dimensions, specifications, engineering and test data are designed to aid in selection and installation.

110 Miniature Oil-Tight Pushbuttons — Bulletin GEA-7127, 10-pp, illustrated in color, features industrial miniature oil-tight push buttons by General Electric Co. Illustrations show flexibility and advantages of the line and how it can reduce panel space requirements 40 per cent. Dimensions, ratings, outlines and drawings are provided. Available forms are shown with stations and enclosures.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 109 and 110.

111 Electrical Connectors — Twelve-pp Bulletin PR-259-1, issued by The Superior Electric Co., describes single-conductor plugs and receptacles designed for line-to-load plug-in connections in distribution and power supply panels, production equipment and other applications. Includes ratings and outline dimensions.

112 Magnetic Pickups — To assist potential users of self-generating input devices in selecting pickup best suited for an application, Bulletin CMP-50 explains how these transducers can be used for accurate mechanical-electrical conversion. A chart simplifies pickup selection by describing the compact input devices in terms of size, electrical output, temperature range and types of mating connectors required. Bulletin is offered by Electro Products Laboratories, Inc.

Pumps, Compressors

113 Volatile Liquid Pumps — Six-pp Bulletin 101 includes cross-section drawings of the standard short coupled vertical turbine model and the canned type vertical turbine model of Layne & Bowler Co.'s volatile liquid pumps. Applications are illustrated. Also explained and illustrated are design details contributing to pumps' efficiency.

114 For Inflammable Liquids — "Canned" pumps for handling inflammable liquids in hazardous locations are covered in Bulletin 728.1, Goulds Pumps, Inc. Gives detailed specifications, materials of construction, performance curves and dimensions for the seal-less centrifugal pumps available in two sizes, capacities to 100 gpm, heads to 100 ft.

115 Pneumatic Pump — Yeomans Brothers Co.'s Bulletin 4601 describes a pneumatic pump for problem materials, such as oils, molasses, brine, paints, acids, and molten salts, slurries and alkalis. Includes selection data, requirement charts, installation diagrams.

116 Single-Stage Compressor — Eighteen-pp Bulletin P-13, Elliott Co., features a performance calculation method which permits selection of proper compressor for most applications. Selection plan includes various curves, plot data on three types of impellers to assure right frame selection, as well as component selector and dimensions tables.

Valves, Piping, Fittings

117 Industrial Valves — Detailed information on industrial valves manufactured by Detroit Controls Div. of American-Standard is presented in 20-pp Catalog 800-A. Also contains competitive cross reference charts and weight tables for comparative purposes, and data covering a variety of pressure controls, temperature controls, solenoid valves and strainers.

118 Pressure Reducing Valve — Described in this catalog sheet of Atlas Valve Co. is a pressure reducing and relief valve for use in water, oil, air or gas service to initial pressure of 4000 psi. Includes drawings, capacity charts, applications and operation details.

119 Vitrified Clay Pipe — This 6-pp brochure on clay pipe, prepared by National Clay Pipe Manufacturers, Inc., describes basic clay products, typical characteristics and uses of vitrified clay pipe, and the latest joints designed to give better control over infiltration, exfiltration and root penetration.

120 Transite Drainage System — Benefits and economies of Transite pipe for storm water drainage and storm sewer systems are described in 10-pp Bulletin TR-252A, released by Johns Manville Corp. Cost comparison data, selection data and specifications are included, as well as photos of typical installations.

121 Cyclone Strainer — Eight-pp Bulletin S-1, Henry Pratt Co., describes design features of a cyclone strainer featuring completely automatic cleaning and/or backwashing. Includes graphs for specifying and selection, and diagrams of typical arrangements.

122 Flange Head Fittings — Listed in 12-pp Catalog 4430 are flange head ends and bent tube fittings with 37-deg swivel nuts added to the line of reusable fittings by Parker Fittings & Hose Div., Parker-Hannifin Corp. Dimensions included

123 Type O Joint — Bulletin E-460-60 describes a Type O joint designed by Evans Pipe Co. for vitrified clay pipe. Includes installation procedures, dimensional data and specifications.

124 Pipe Connections, Accessories — This 44-pp 1960 catalog of Gray Tool Co., presents pipe connections and accessories designed on the Grayloc seal principle. Covers new types and ratings of Grayloc clamps, collar type unions, flanges, closures and bleeder valves. Products with related applications are cataloged, including bi-metallic pipe, fittings. A 10-pp table of allowable working pressures covers pipe and connections from 1 to 30 in. to 1500 F. Relative costs tabulated.

Air Conditioning

125 Packaged Air Conditioners — Performance characteristics and engineer-

ing features are detailed in color-illustrated Bulletin 8825, 12-pp, from American-Standard Industrial Div. Typical installation photos showing units with and without discharge plenum are included to illustrate a discussion of owner advantages of the unit. A ready-reference table provides physical data and indicates range of capacities available in the air-cooled and water-cooled units.

126 Central Air Conditioning — Illustrated and described in Airtherm Mfg. Co.'s 14-pp Bulletin 404 is a line of air conditioning, heating and ventilating central station units from 400 to 30,000 cfm Includes sizing data graphs and complete specifications.

Insulation

127 Glass Fiber Insulation — Advantages to be gained from insulating storage tanks with Gustin-Bacon Mfg. Co.'s glass fiber insulation are detailed in this 8-pp bulletin. Thermal conductivity curve included and application methods are described.

128 Calcium Silicate Insulation — Pipe and block insulation of calcium silicate for use in power, chemical, petroleum, petrochemical and manufacturing industries is featured in Form 6472 of Philip Carey Mfg. Co. Lists heat transmission data, physical and thermal characteristics, and gives standard sizes and recommended thicknesses.

129 Pipe Insulation — Kaylo-Klad, a high temperature insulation for industrial piping in the power, chemical and refining industries, is described and illustrated in this bulletin by Owens-Corning Fiberglas. Advantages covered include: "locking out" weather, fabrication with simple tools, and fast installation.

130 Dual-Density Liner — Micro-Bar, a fiber glass duct liner, is described by Johns-Manville Corp., in 8-pp Brochure IN-302A. Stresses advantages of this dual-density liner in checking air erosion, cutting noise, and improving insulating efficiency etc. Also describes the material itself. Illustrates various application techniques, before and after forming the sheet metal, including joints that eliminate use of coatings, sealers or metal nosings.

Instruments and Controls, Automation

131 Automation for Utilities — Automated equipment and systems for electric utilities are described in General Electric Co.'s Bulletin GEA-7044, 24 pp. All phases of system operation — generation, transmission and distribution — are covered, as well as automatic load dispatching covering the areas of load-frequency control and economic loading to minimize transmission losses.

132 Servo System — Instruction Manual 60-77, 12 pp, describes the electro hydraulic building block velocity servo system of Vickers Inc., Div., Sperry Rand Corp. It is intended as an aid in setting up and trimming the servo system, with step-by-step descriptions of procedure and wiring diagrams.

133 Dynamic Storage Computer — Mathematical applications of the Dystac (dynamic storage analog computer) are covered in this 16-pp report released by Computer Systems, Inc. Covers dynamic memory, sequential calculations, the definite integral, multiple integration, continuous memory. Computer Systems, Inc.

134 Recording System — Technical Bulletin 210 of Daystrom, Inc., describes Tele-scan recording systems for transmitting data to distant computer facilities via standard telephone circuits. Typical system is charted and details covered.

135 Turbine Instruments — Bulletin GEZ 3078-1, 12 pp, includes description and specifications of General Electric Co.'s compact redesign of a turbine supervisory instrument system that charts a permanent record of mechanical performance throughout starting and running periods. Detailed description of system's ability to monitor vibration, shaft eccentricity, shell and differential expansion, speed and valve position is included. A companion piece, Bulletin GEZ-3077-1, details credits allowed by manufacturer for earlier TSI models when replaced by the new system.

136 Instruments, Controls — Pressure gages, thermometers and control instruments are described in 6-pp Bulletin 3020 offered by U. S. Gauge, Div. American Machine and Metals, Inc. Photos illustrate each item, with information on dimensions, accuracies, construction features and suggested uses.

137 Temperature Regulator — Eight-pp Catalog J180-1, OPW-Jordan Corp., contains detailed information on sliding gate and plate temperature regulators designed for use on steam, water, air, oil, gas or chemicals. Includes sizing charts, flow curve, specifications and data.

138 Flow Meters — Presented in Catalog C295-1 and Instrument Data Sheet 10.3-9, Minneapolis-Honeywell Regulator Co., is detailed information on flow meters using vortex-velocity principle for measuring liquids and gases. Engineering data and diagrams included.

139 Liquid Level Transmitter — Pressure and liquid level transmitter operating on the force-balance principle is featured in Conoflow Corp.'s Bulletin P-36-1. Operation and design details are illustrated and specifications included.

140 Alarm Rotameters — Featured in Bulletin 18A are Schutte and Koerting Co.'s magnetic and electronic instruments for measuring fluid rates of flow and warning of abnormal flow rates. Covers application, construction and operation, and includes dimensions, sizes and capacities.

141 Weather Sensitive Controls — Automatic controls that govern inside comfort by outdoor temperatures are described in Bulletin G-0260 by Automatic Devices, Div., American Machine and Metals, Inc. Covers Weather-Man units which measure the weather, reset heating rate and hours proportionately; and Weather-Flo regulators to effect continuous circulation of water or air at right temperature for greatest comfort.

142 Acoustical Control Units — Detailed description of acoustic terminal control units for all-air high-velocity systems is contained in 36-pp Catalog 1060 from Carnes Corp. It provides information and specifications on three ceiling models and two window/perimeter models, engineering data on systems noise and tables of static-pressure losses and regains.

143 Regulators, Manifolds — Industrial gas regulators and portable manifolds manufactured by Linde Co., Div., Union Carbide Corp. are illustrated and described in 16-pp Form 55-085. Includes specifications and cross-sectional diagrams showing details of design and operation.

144 Indicators, Control Stations — Specification FS-301-9 of Minneapolis-Honeywell Regulator Co. describes new ElectriK Tel-O-Set indicators and indicating control stations which continuously indicate and record standard 4-20 ma d-c output of suitable transmitter or transducer. Controller specifications, dimensions and features included.

145 Automatic Tape Analyzer — Bulletin WC-127, issued by Graver Water Conditioning Co., covers all facets of an automatic tape analyzer for measuring trace quantities of insoluble solids in liquids, including operation principles, applications and specifications.

Mechanical Power Transmission

146 Variable Speed Drive — Eight-pp Bulletin GEA-7019, of General Electric Co., describes adaptability of the Thymotrol drive to machine feed and spindle applications, reeling equipment, conveyor systems, processing equipment, and other applications where precise speed control is essential. Ratings and specifications, and dimensions are given.

147 Variable Speed Drives — Operating principle and other information on a variable speed drive which uses the compound planetary gear system is presented by Graham Transmissions Inc. in 12-pp Bulletin 550. Explains how variable speeds are obtained, gives operating advantages and selection data.

148 Shaft-Mounted Reducers — Twelve-pp Form F-2003 provides technical information on shaft-mounted geared speed reducers as well as selection instructions on the Shaftmount Syncrogear of U. S. Electrical Motors Inc. Tables show service classifications to be applied in determining types of speed reducers for various industrial applications and conditions of usage. Also provided are high and low gear-ratios for each horsepower and frame size, with preferred ratios for specific motor rpms indicated.

149 Stepless Variable Speed — Illustrated and described in 16-pp Catalog ZM-400C by Zero-Max Co. is a line of stepless variable speed drives for fractional horsepower applications. Operating features and installation suggestions are accompanied by numerous diagrams and tips on power transmission.

Water Management

150 Steam Purity Measurement — This data sheet issued by Betz Laboratories, Inc. discusses how the determination of the sodium content of steam has unveiled causes of turbine and superheater deposits heretofore undetected. Describes portable field equipment.

151 Condensate Scavenging — High-rate condensate scavenging for high pressure central stations is the subject of 12-pp Bulletin WC-128. Advantages are considered, and equipment such as condensate filters and mixed-bed demineraliz-

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Completely shop fabricated, with burners, controls and accessories installed before shipment.

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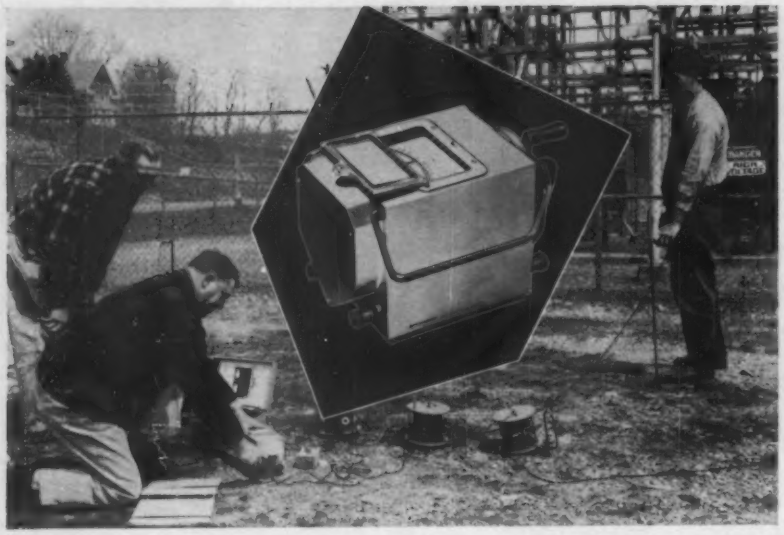

UTILITY PREVENTS ELECTROLYTIC CORROSION—RELIES ON MEGGER® GROUND TESTER

Worcester County Electric Company's underground cable system in central Massachusetts was the target of severe corrosion caused by low ground resistance to stray electrical currents, until laboratory tests revealed the situation.

After acting quickly to repair the corroded sections, the utility embarked immediately on a preventive maintenance program to stop further deterioration. The program was built around continuing tests with a Megger Ground Tester, selected because of the speed, ease and accuracy it provides in obtaining readings.

After a year's use, Worcester Electric finds that the Megger Ground Tester gives these advantages:

1 *It functions at all times*
2 *It does not have to be balanced*
3 *It does not require a power supply*
4 *It requires a minimum of maintenance*
5 *It takes rapid, accurate readings*

Savings attributed to the Megger Ground Tester preventive maintenance plan run into thousands of dollars per year. Worcester Electric is now able to spot areas of low resistance in their cables sufficiently in advance of actual breakdowns so that complete counteracting measures can be taken.

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The James G. Biddle Co. File 25 is an excellent fund of information on grounding problems. It includes a manual on Ground Resistance Testing, and bulletins on "Grounding Electrical Circuits Effectively" and "Grounding Principles and Practices Applied to Industrial Plants."

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ers, and analytical procedures such as the automatic tape analyzer are described by Graver Water Conditioning Co.

152 Continuous Blowdown — Control of boiler water concentration without heat loss and other advantages of the Henszey automatic continuous blowdown system are detailed by Sentry Equipment Corp., in this product bulletin. Typical systems are diagrammed.

153 Treatment for Cooling Waters — How to treat water to insure trouble-free operation of cooling water systems is outlined in Nalco Chemical Co.'s 6-pp Reprint 88. Covers major factors that cause problems in industrial cooling systems and includes a flow diagram that points up corrosive factors in cooling water systems.

154 Water Demineralizers — Mixed-bed, two-bed and four-bed demineralizers, designed by Barnstead Still and Sterilizer Co. for industrial water purification, are featured in 36-pp Catalog 160. Profusely illustrated with charts, specification drawings and installation photos.

155 Chemical Feed Systems — Technical Bulletin CS-107, issued by Ionac Chemical Co., Div., Pfaudler Permutit Inc., describes a packaged chemical feed system for accurate control of amounts of reagent chemical to be added to boiler feed water. Diagram of typical installation and piping layout, specifications included.

156 Briquet Feeding System — Details on egg-shaped briquets designed to dissolve at a uniform rate releasing continuous chemical feed into treatment systems are presented in Technical Bulletin CS-110. Operation is diagrammed and advantages detailed by Ionac Chemical Co., Div. Pfaudler Permutit Inc.

157 Slime Control — This water conditioning data sheet of Betz Laboratories discusses slime control with chlorine and non-oxidizing biocides. Explains how judicious use of chlorine and supplemental use of other biocides will extend cooling tower life.

158 Small-Flow Sewage Treatment — Eight-pp Bulletin 7315, released by Dorr-Oliver Inc., describes a unit providing complete sewage treatment in a single tank using mechanized sanitary engineering methods, for small to medium-sized industrial and other installations.

Lubrication

159 Solid Lubricants — The theory and practice of lubrication by solids are discussed in 24-pp Bulletin 124 by The Alpha-Molykote Corp. Describes major advantages of molybdenum disulfide solid lubricants.

160 Automatic Valve Lubricator — Illustrated and described in 8-pp Bulletin 617 of The Rockwell Mfg. Co. is an automatic lubricator for plug valves. Construction details, installation and operation details are fully described.

Other Equipment

161 Rotating Shaft Seals — Custom-designed mechanical shaft seals for all types of products and operating conditions are featured by Cartriseal Corp. in 34-pp Catalog 660. Data on general operating ranges and limitations which determine choice of seal to be used is presented, along

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PRESSURE SEAL
Fig. 16031—New, steel pressure seal "Y" globe valve for 600 pounds.
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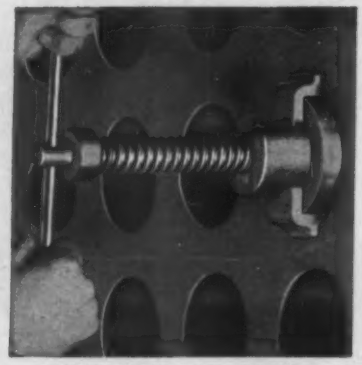
for most hand-hole shapes and sizes

Standard Roto Seat Scrapers are available for the following equipment. Special types made to order.



Illustrating ease of operation of Roto Hand-hole Seat Scraper.

Type of Boiler	Opening	Tube Size
Babcock & Wilcox # 4	Round	2"
" " " #41	Oval	2"
" " " #70	Round	3"
" " " #48	Oval	3½"
" " " #40	Oval	3½"
" " " #24	Oval	4"
" " "	Oblong	4"
Bros	Round	3¼"
Casey Hedges	Oval	3½"
" "	Oval	4"
Combustion Eng'rg	Round	3"
" "	Oval	3"
Edgemoor	Oval	4"
Erie City	Ellip	2½"
" "	Oblong	3¼"
" "	Ellip	3¼"
" "	Pear	4"
Foster Wheeler	Oblong	2½"
" "	Oblong	3"
" "	Ellip	4"
Geary	Oblong	4"

Type of Boiler	Opening	Tube Size
Heine	Round	3½"
"	Oval	3½"
International Boiler 2	Oblong	3"
Keeler	Round	3½"
"	Round	4"
"	Diamond	3½"
"	Diamond	4"
Lasker	Oblong	
Murray	Oval	3½"
"	Oblong	4"
Oil City	Oval	3½"
" "	Oblong	4"
Riley Stoker	Ellip	3¼"
Springfield	Ellip	3¼"
Union Iron Works	Pear	4"
Henry Vogt	Ellip	3¼"
" "	Oval	4"
Walsh & Weidner	Oval	4"
Wickes	Ellip	2½"
"	Ellip	3¼"
"	Pear	4"
"	Round	4"

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with construction and operating features of various seals.

162 Incinerator Stoker — Illustrated and described in Detroit Stoker Co.'s Bulletin 701 is a reciprocating grate incinerator stoker for destruction of municipal and industrial garbage and refuse. Features and advantages are detailed.

163 Gas Turbine — Bulletin SAE-109A describes General Electric Co.'s gas turbine for industrial and other applications. Performance specifications, dimensions and installation data are included, along with review of application potential.

You'll save time in ordering bulletins by using the Reader Service Cards on page 109. Of course we honor letterhead requests—but it takes us somewhat longer to handle them

164 Storage, Reclamation Equipment — Catalog E, 28 pp, of Sauerman Bros., Inc., describes and illustrates DragScraper storage and reclamation. Installation photos and layout drawings show handling of chemicals, ores, coal, coke and other bulk materials. A table lists more than 50 typical materials handled. Both indoor and outdoor equipment is covered, and booklet also describes buckets, blocks, hoists and other components of DragScraper machines.

165 Metal Framing Construction — Catalog 710, released by Unistrut Products Co., is a 36-pp handbook giving application and installation information, specifications and methods of attaching to structures using Unistrut metal framing. Typical illustrations show such applications as support of pipe, conduit and cable, rigid frame construction, fluorescent fixture supports, raceways, bus bar supports, substation structures and mount equipment.

166 Drafting Pencils — A variety of pencils and other items for drafting and reproduction work are featured in this 24-pp catalog released by J. S. Staedtler, Inc. Includes pencils for work on drafting film, for color coding on tracings, non-reproducing pencils for making temporary work notes on drawings.

167 Welding Data — This 148-pp pocket-size maintenance welding data book, issued by Eutectic Welding Alloys Corp., provides a guide, indexed by application, to nearly 200 Eutectic welding rods, electrodes, and chemical aids. It illustrates and explains general welding techniques and joint design hints, and covers such topics as elimination of warping, distortion, embrittlement and other base metal damage; wear, impact and corrosion resistance, color match, and machinability of welds.

168 Crushers, Mills — Twelve-pp Bulletin 4020 illustrates and briefly describes each type of crusher produced by Pennsylvania Crusher Div., Bath Iron Works Corp., and indicates typical applications. It is a guide to preliminary crusher selection and keyed to more detailed bulletins on specific crushers.

169 Process Equipment — Described in 12-pp Bulletin G-3D is a line of equipment designed by Fuller Co. for the process

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Unmistakable water level readings are assured with Diamond's MP-3000 Multi-Port Bi-Color Gauge, equipped with condensate by-pass. A major reason for such performance is the unique and exclusive by-pass which traps any condensate before it reaches the port channel. The absence of condensate in the port channel assures a distinct bi-color image — red for steam, green for water. Regardless of operating pressure, there's a Diamond Gauge to provide accurate water level readings. Write for complete information or contact your local Diamond representative.

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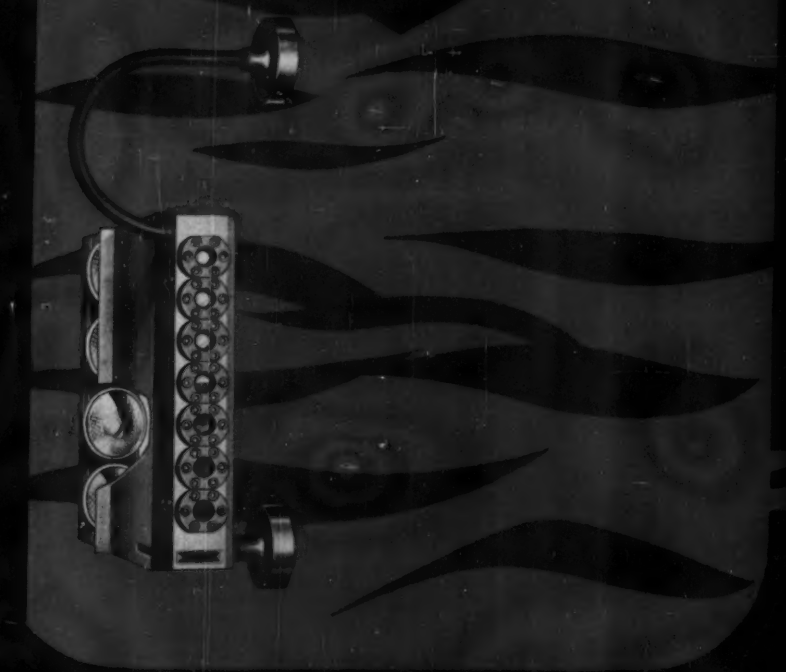
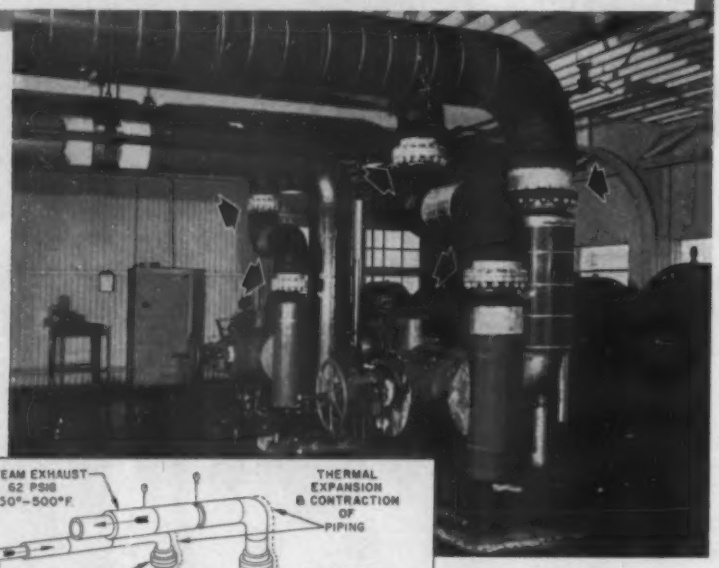
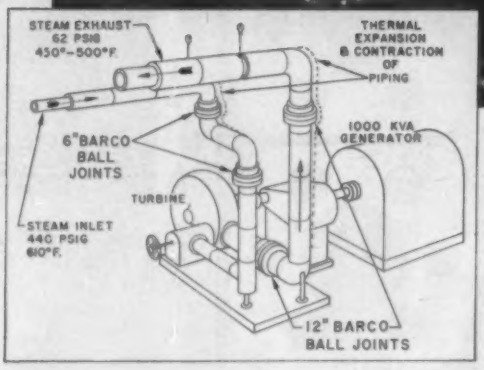


Barco Saves Time, Money on Steam Turbine Piping—





BARCO **BALL JOINTS**

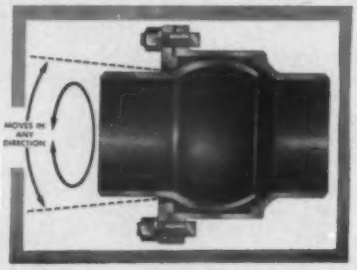
1. Handle Expansion **2. Relieve Torsion** **3. No "End Thrust"**

PROBLEM For the turbine installation shown above, layout of the piping presented involved pipe stress calculations to allow for thermal expansion and to eliminate torsional effects. In addition, a considerable expenditure had to be allocated to cover construction of heavy pipe anchoring and to control expansion "end thrust". *Could engineers find a better way to solve these problems? THEY DID!... and they saved about $2,000.00.*

ANSWER Instructions were simple: (A) "Install Barco Ball Joints —two* in each riser near turbine." (B) "Cut loose anchor stops; allow piping to move freely in all directions." (C) "Use spring hanger supports for the long horizontal runs of piping."

*Standard Type N for exhaust; High Temperature Type HT Joints for steam inlet lines.

Barco Ball Joints provide convenient points of flexibility in piping to allow for both expansion and twisting. They develop NO "END THRUST"; expensive anchoring is not required. Easy to engineer. Rugged all-steel construction with no thin wall sections, no critical points of fatigue, no rubber seals. No lubrication required. Sizes and styles to meet your requirements. *Ask for new Bulletin 31B, "Thermal Expansion and Contraction in Piping."*



BARCO MANUFACTURING CO.

547M Hough Street, Barrington, Illinois

In Canada: The Holden Co., Ltd., Montreal

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industries. Operating principles are explained, and photos and drawings of typical installations included. Covers, pneumatic conveyors, rotary compressors and vacuum pumps, horizontal grate coolers, suspension type preheaters, draft fans, others.

170 Vibration, Noise Control — Eight-pp Bulletin K4G, issued by The Korfund Co., gives engineering specifications and performance data for a variety of products for control and measurement of machinery vibration, shock and noise. Selection chart included.

171 Hinged Closures — Features and advantages of hinged closures, designed by Tube Turns Div., Chemetron Corp., for blanking off pipe line ends and tank or vessel openings are detailed in Bulletin TT956. Safety features are outlined and dimensional data included. Tube Turns Div., Chemetron Corp.

172 94 Chemicals Reviewed — Organic and inorganic chemicals — 94 in all — produced by Hooker Chemical Corp. are reviewed in this 16-pp Bulletin 100-D. Gives factual information on 88 commercially produced products, six development ones, including 20 recently developed chemicals. Covers acids, alkalies, the elements chlorine and phosphorous, metallic salts, phosphorous and sulfur compounds, chlorides, chlorobenzenes, others. Physical data, chemical formulas, uses and shipping information presented.

173 Nickel-Alloy-Bonded Tubing — Advantages of nickel-alloy-bonded steel tubing are detailed in this 8-pp report of M. L. Sheldon & Co., Inc. Includes comparative data on corrosion resistance of stainless, low alloy and metallic coated steels to combustion gases emanating from a pulverized fuel-fired steam generator.

174 Fuel Cell — A preview of developments in the use of fuel cells for converting chemical energy directly into electricity is given in this illustrated 10-pp booklet. Theory of the fuel cell for direct conversion of chemical energy of basic fuels into electric current is detailed by Pratt & Whitney Aircraft, Div., United Aircraft Corp.

175 Magnet Wire — Catalog WC-8289 contains 50 pp of comprehensive selection data on General Electric Co.'s line of magnet wire. A feature is a guide to preliminary selection of wires according to insulation and other requirements. Nomograms are included for computing cross-sectional areas, resistance, and weight of rectangular conductors.

176 Multi-Tube Exchangers — Multi-tube, double-pipe heat exchangers for high-capacity applications are featured in 8-pp Bulletin 111, issued by Brown Fintube Co. Cutaway drawings show details of shell to tube closure and return bend housing and tables list complete specifications.

177 Electric Heaters, Devices — Product and application data for General Electric's Calrod tubular heaters, finned tubular, cartridge, strip, insertion, and vane heaters, forced and natural convection air heaters, and oven heaters are presented in 48-pp Bulletin GEC-1005K. Includes sections on heater control and wiring diagrams, application and heater selection in both long and short forms, as well as photos and dimensional drawings of the equipment.

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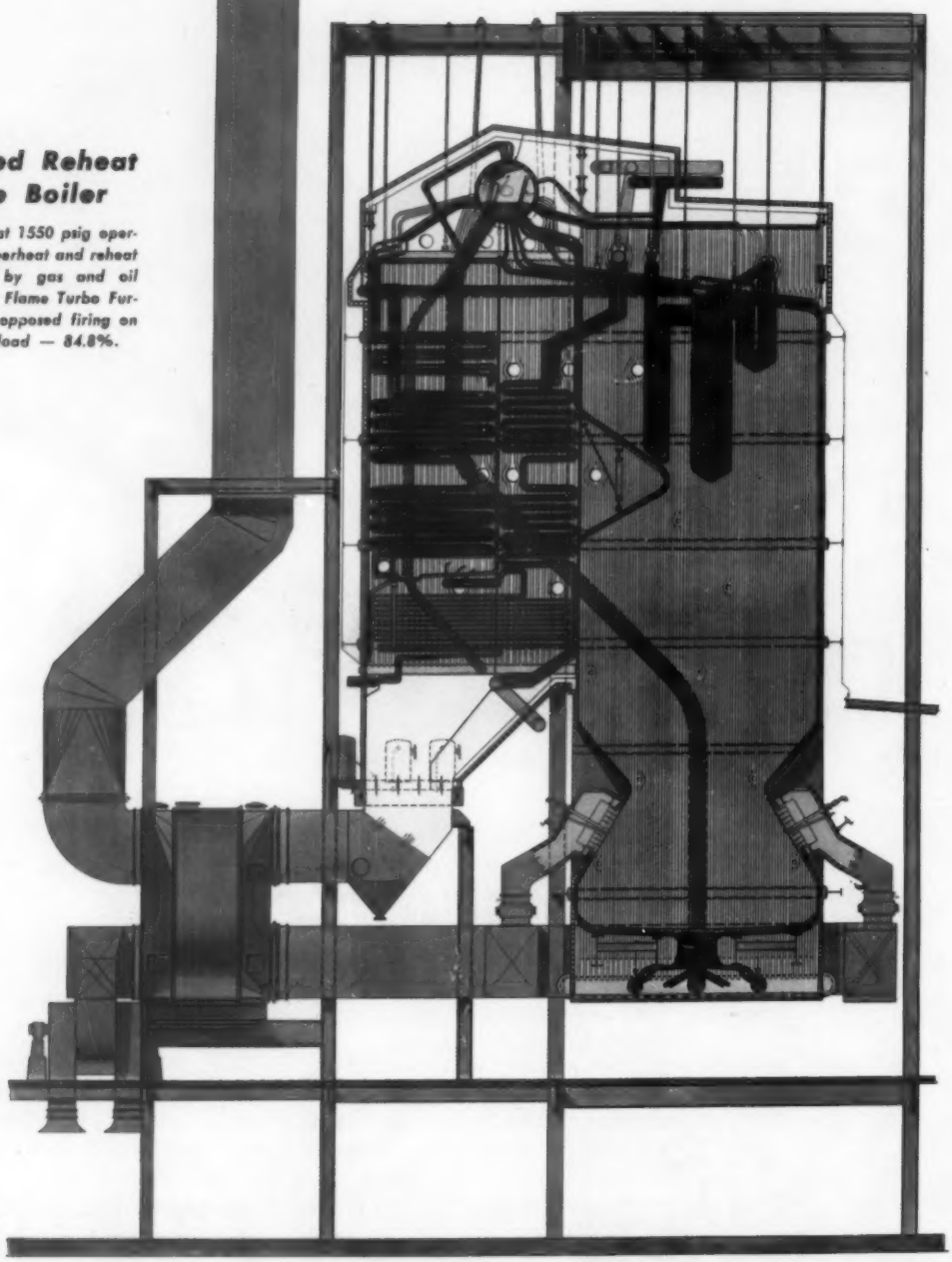

Ask your Riley representative for detailed information about Riley Turbo Furnace Boilers — or write direct to RILEY STOKER CORPORATION, WORCESTER, MASSACHUSETTS.

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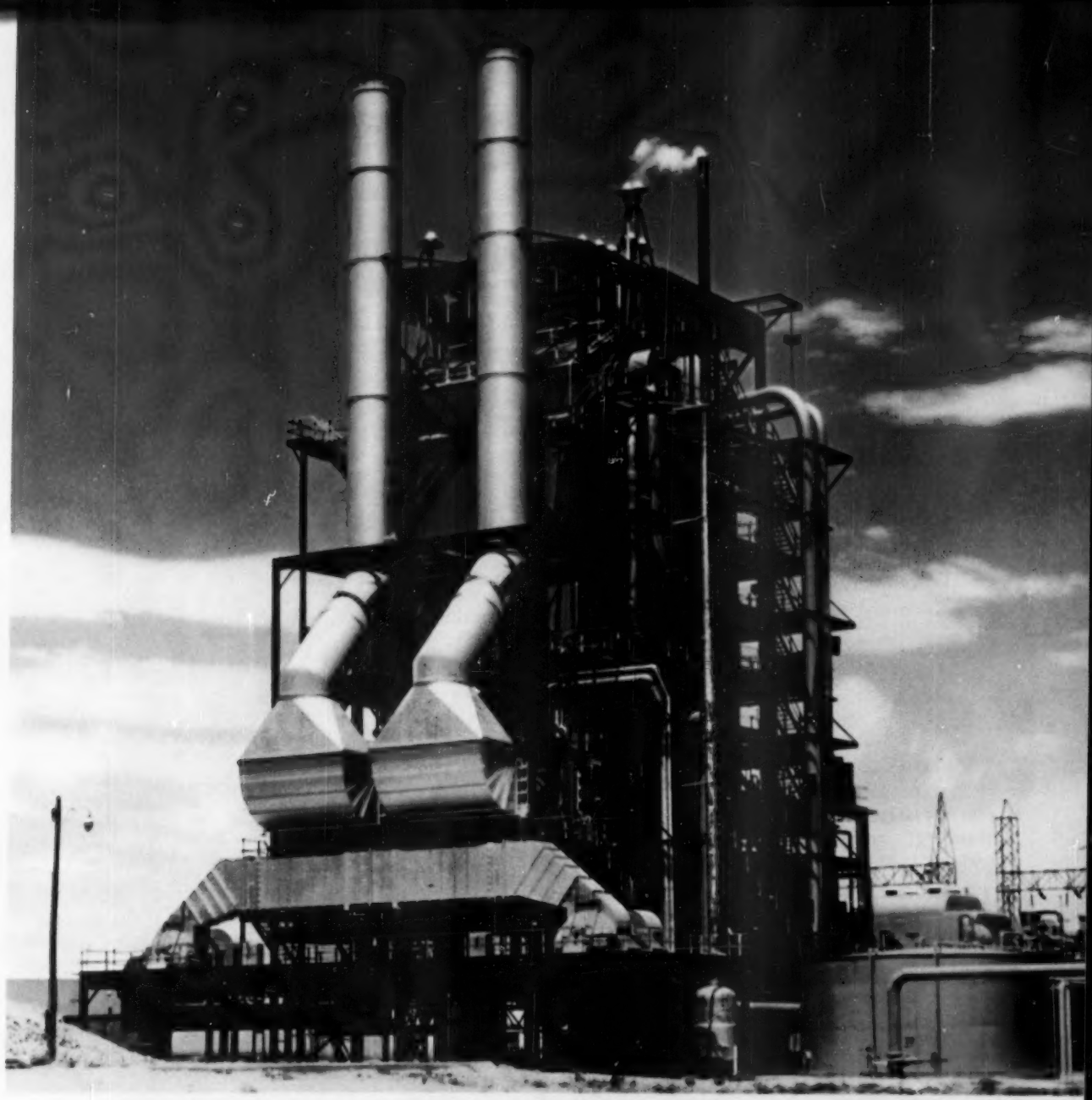

Burning gas and oil now, it may someday become both practical and economical for Texas Electric Service Company to fire its new Riley Turbo Furnace Boiler at Permian Basin Steam Electric Station, Monahans, Texas, with coal.

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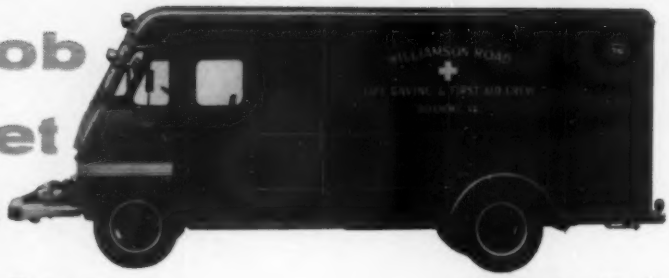

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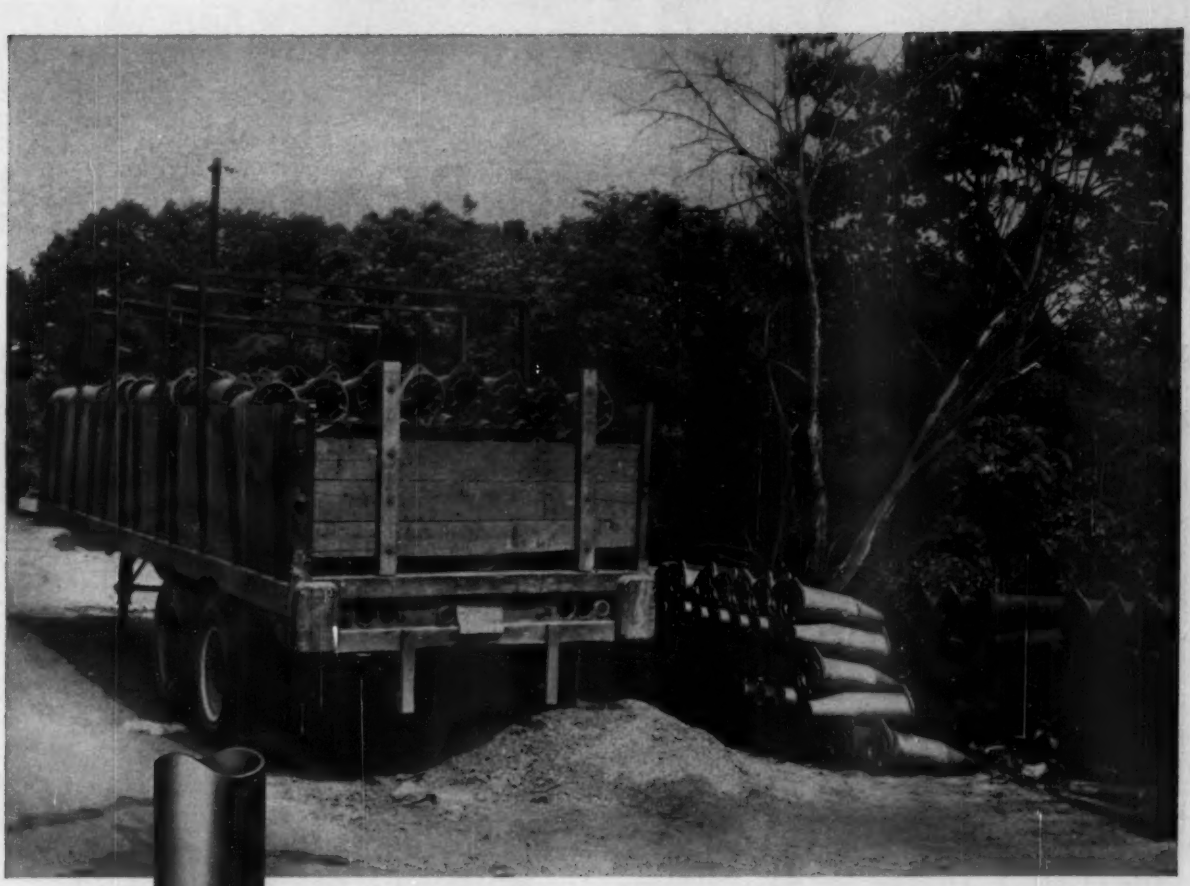

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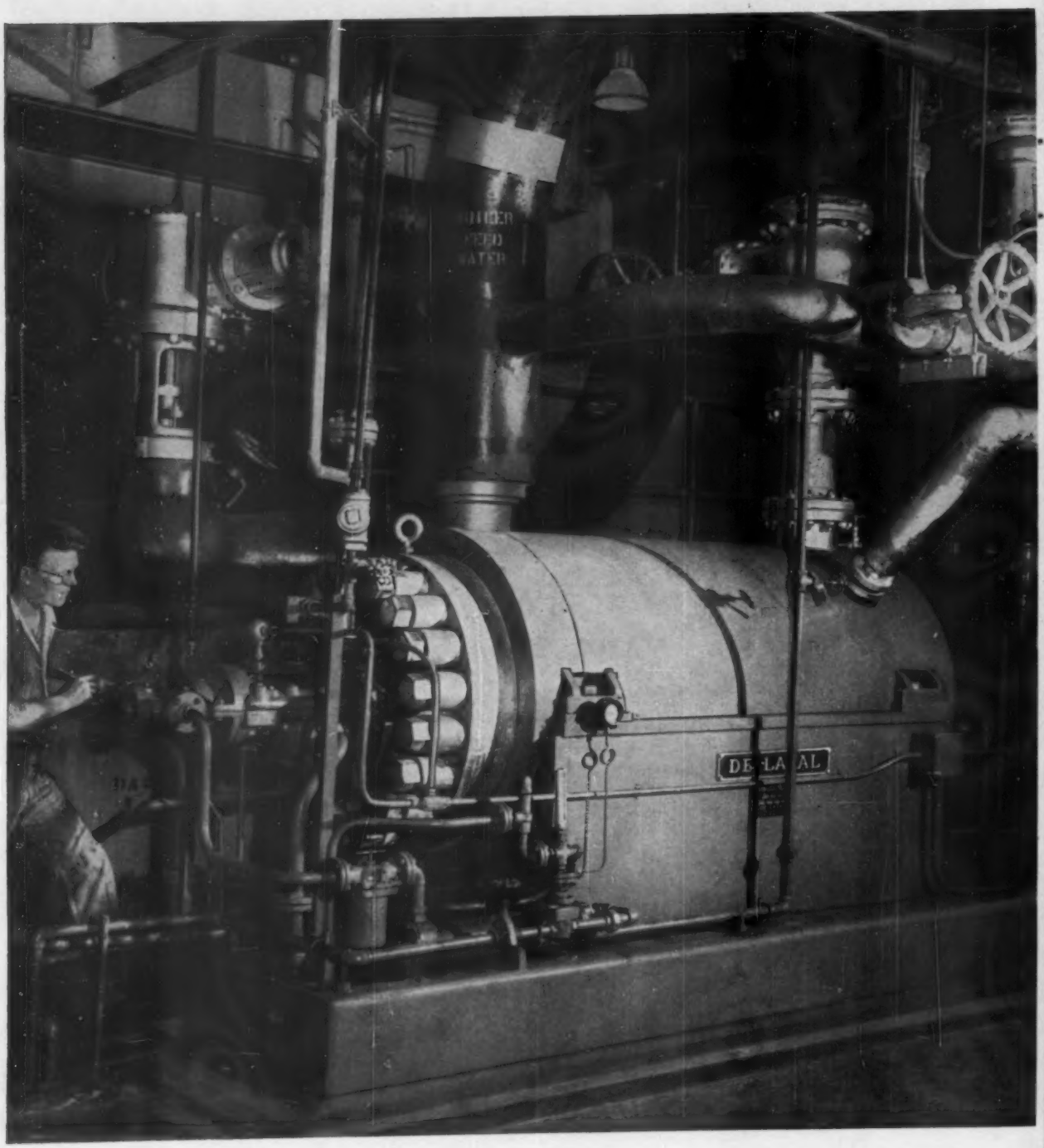

latest unit at Central Hudson

Burns and Roe Inc., Engineers and Constructors, complete third unit at Danskammer Station

To meet increased load demand, Central Hudson Gas & Electric Corporation has added a 140,000 KW 2400 psig main unit at its modern Danskammer Steam Station. Providing dependable boiler feed service are two 2500 HP direct motor driven half capacity De Laval barrel type boiler feed pumps. The earlier units have De Laval full capacity variable speed boiler feed pumps.

← Each De Laval pump has intermediate pressure bleed off for use in controlling steam temperature from reheater.

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The Story of Edward Research

and the "Perfect" Globe Valve

Edward designers built the Figure 848 forged steel globe valve from scratch. In an art where most development effort must be directed toward modification, adaptation, and refinement of existing technology, the 848 story is almost unique. The objective was simple: To design and construct a perfect 600-lb-class globe valve in the ¼" to 1" size range. (Basic rating 600 lb at 910 F, 2000 lb WOG.) That the project was virtually successful is a tribute to the ingenuity of the Edward Research Staff and the equipment which enabled them to validate their progress. Here, is that story.

Three areas were given special consideration by the Edward staff of engineers and metallurgists when they set out to design a "perfect" valve. They were: 1. Body Shell and Bonnet Joint; 2. Seat Tightness; 3. Packing Area. Although each area was treated separately, the relationship of one to the other was a factor that had a great deal to do with the outcome of the project.

A series of "torture" tests such as the pressure pulsator shown on the opposite page carried each part and joint to the point of destruction. Thus Edward designers were able to trace each weakness to its source. Perhaps no other valve ever designed has been known and understood so well by the men who designed it.

1. BODY SHELL AND BONNET JOINT. The valve bonnet was bolted finger tight; it tested at 2000 psi. Then, at full design tightness on all four bolts, the bonnet joint did not leak until 11,000 psi (5½ times design pressure!) was applied. Next, 8000 psi applied 100 consecutive times produced no apparent valve damage. Internal pressure was pulsated from 200 to 2000 psi for 10,000,000 cycles with no apparent damage!

The bonnet cap screws were subjected to 350% of design tightness before failure occurred. Further evidence of design effectiveness was the unpredictability of failure. In one case the threads stripped; in another the bolts broke off, and in other there was excessive bending of the bonnet flange. There was no *one* apparent point of weakness!

2. SEAT TIGHTNESS. Similar destructive tests were conducted on the valve stem and seat. The valve required on 65% of standard test closing torque to seal tight at 2000 psi. And 350% of standard torque was built up before the stem sheared below the handwheel. 100 operations at 2½ times standard torque did only negligible damage to seating surfaces. Even after this test only 90% of standard test torque was needed to hold 2000 psi.

3. PACKING AREA. Six times as much load as actually required to seal the packing chamber was applied to the gland bolts without causing damage. A load 3½ times greater than required for sealing was applied 50 times, also without causing damage.

Thus the "perfect" globe valve was designed; perfect not because it can't fail, but perfect because it has no apparent weaknesses. The full design and construction story is told in Edward Catalog 14-G.

Edward builds a complete line of forged and cast steel valves from ¼" to 24" for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

EDWARD STEEL VALVES
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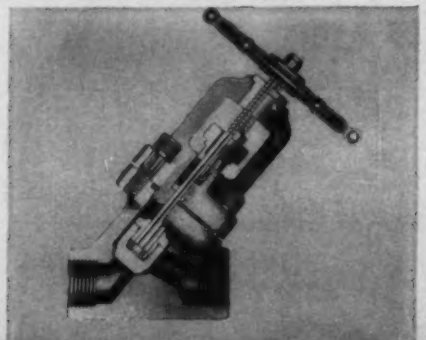
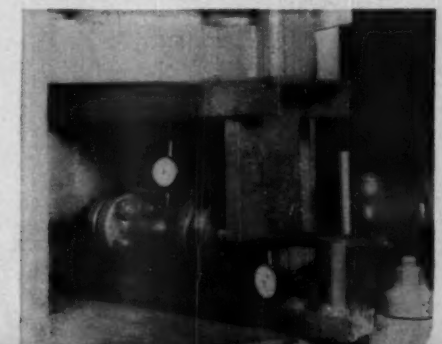
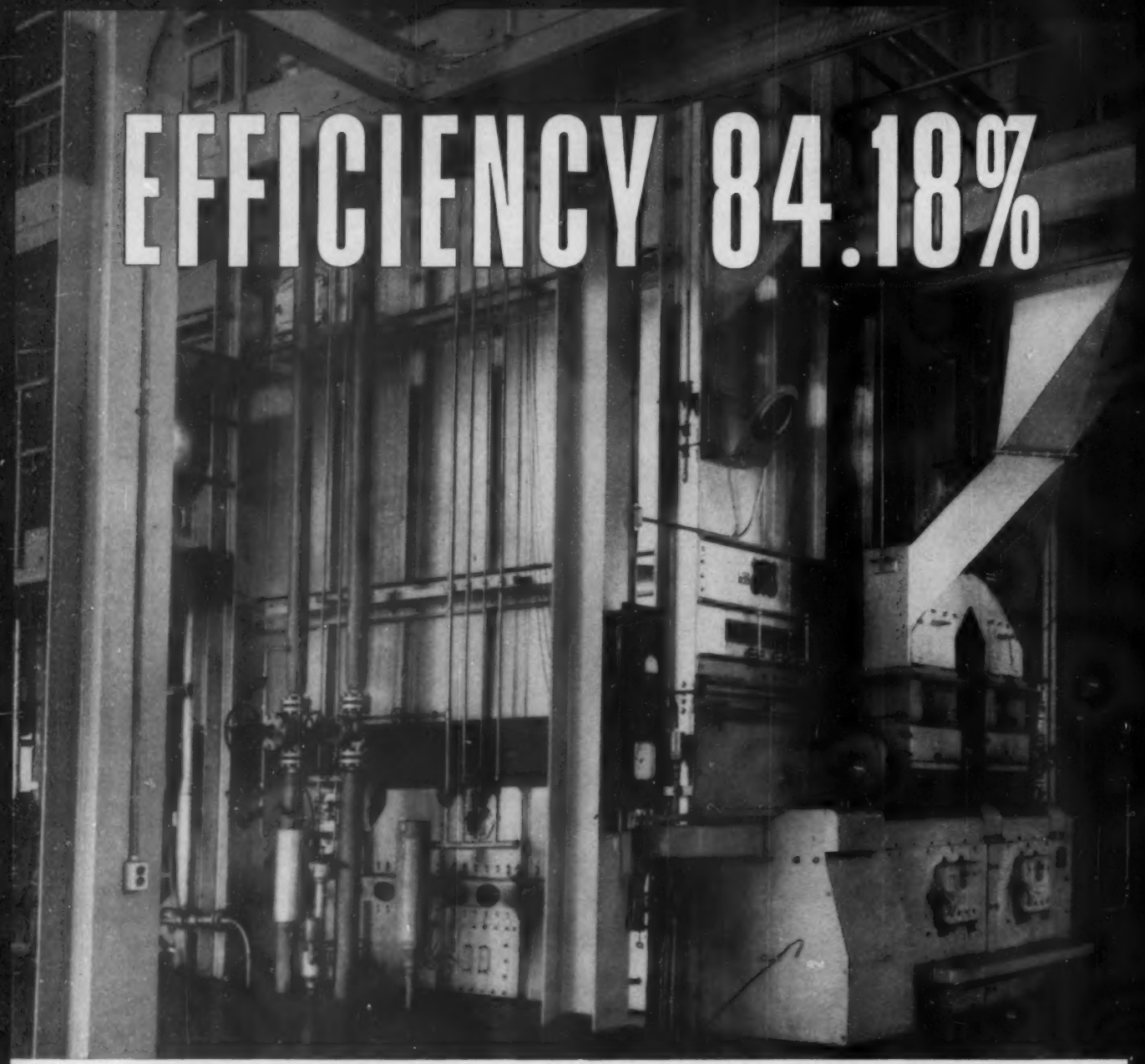
Chief Engineer C.A. Siver and Design Engineer Don Easton observe effects of pulsating pressure on newly designed Figure 848 forged steel globe valve in Rockwell-Edward Research Lab.

Rugged forged steel body . . . combined with high-strength stainless steel gland bolts and bonnet bolts, aluminum-bronze alloy yoke bushing, asbestos-stainless spiral gasket and other premium features . . . makes the Figure 848 a virtually "perfect" small steel valve.



Test arrangement produces uniform bending moment on valve and ½" pipe. Test show that the strongest pipe likely to be attached to the valve will yield with less than ½ the bending moment required to distort body.





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MORE FACTS: Many types and sizes of Union Steam Generators are covered in illustrated Bulletin GB-959. Write: Union Iron Works, Erie, Pa.

UNION

steam generators

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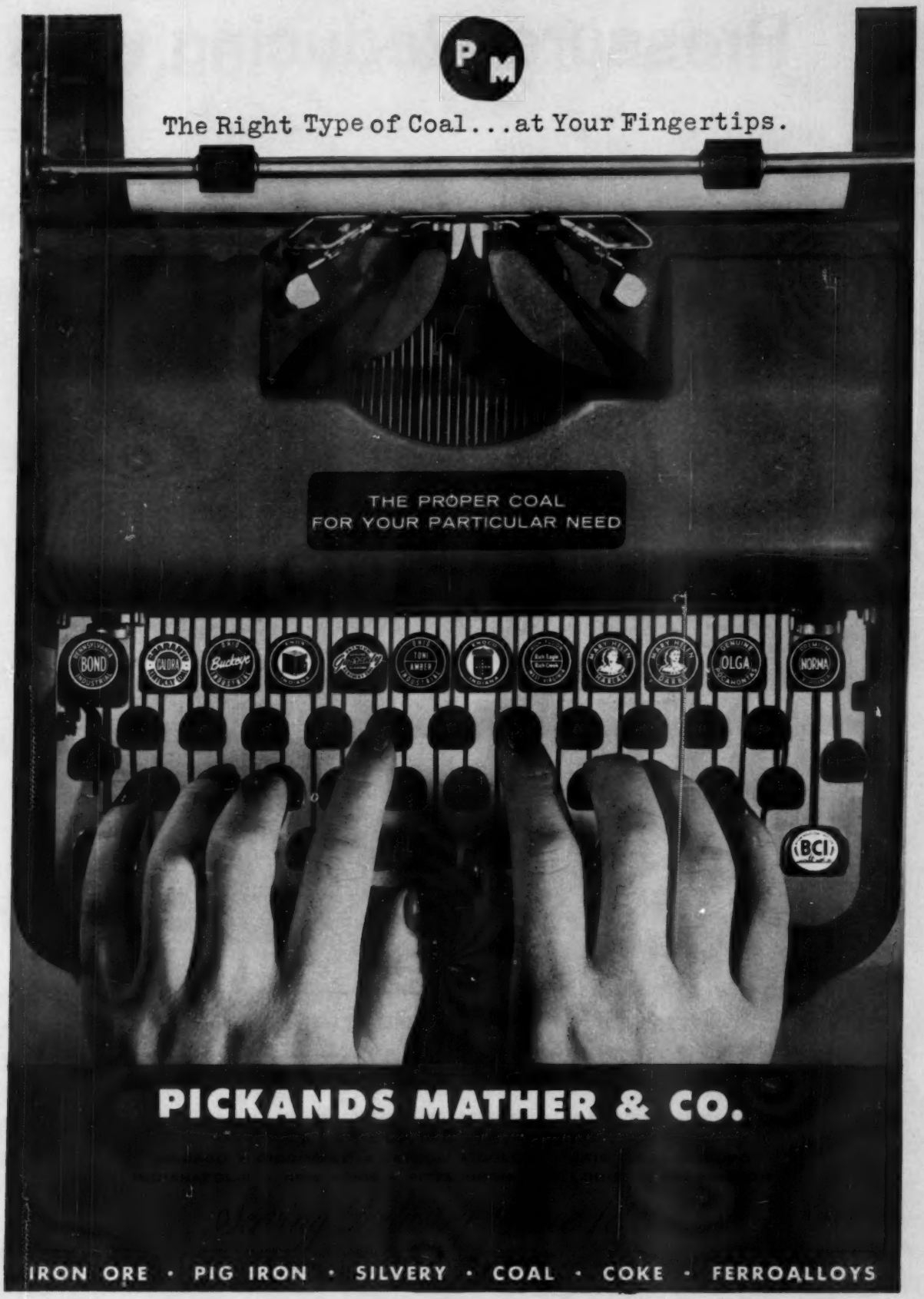

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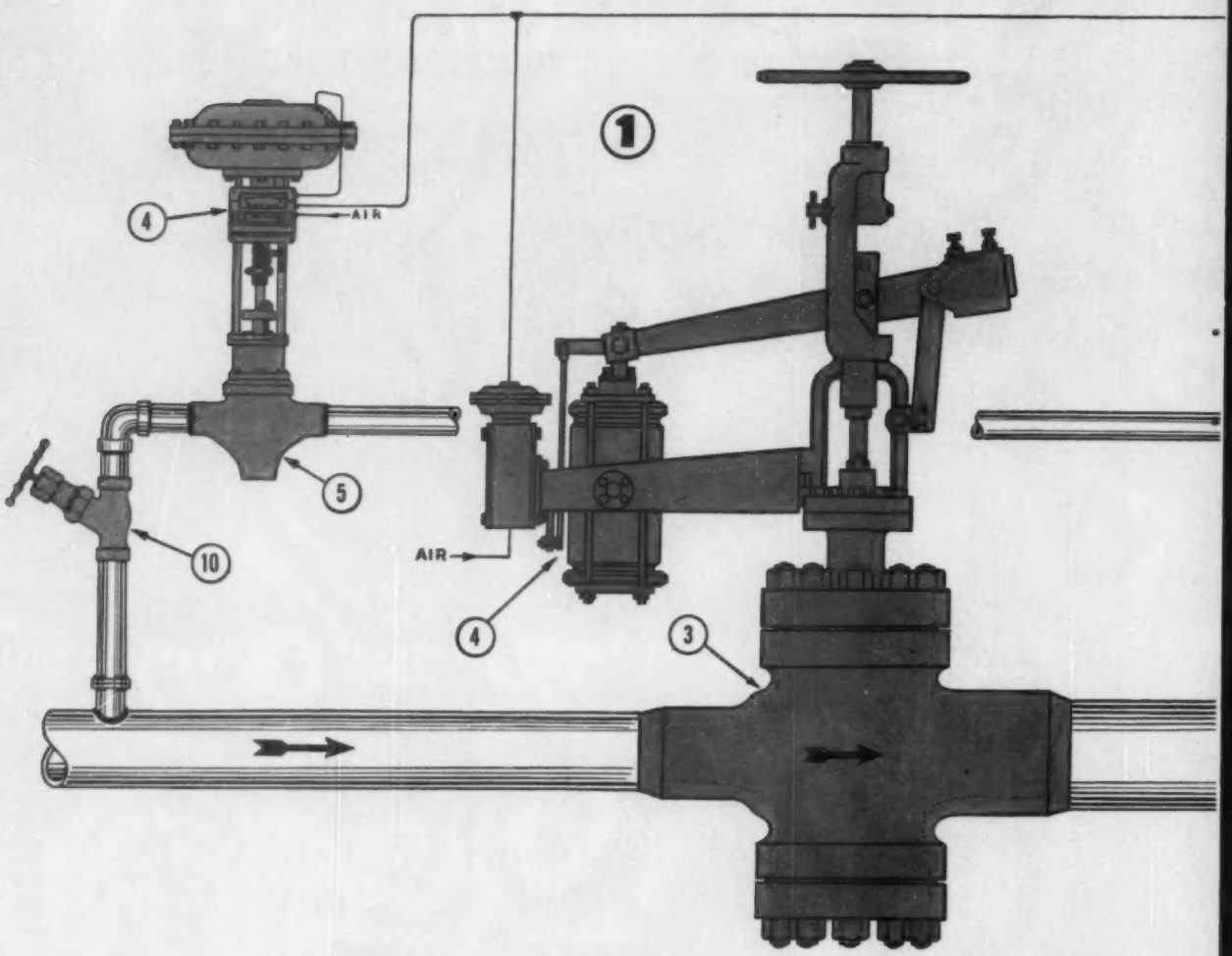
Pressure Reducing and



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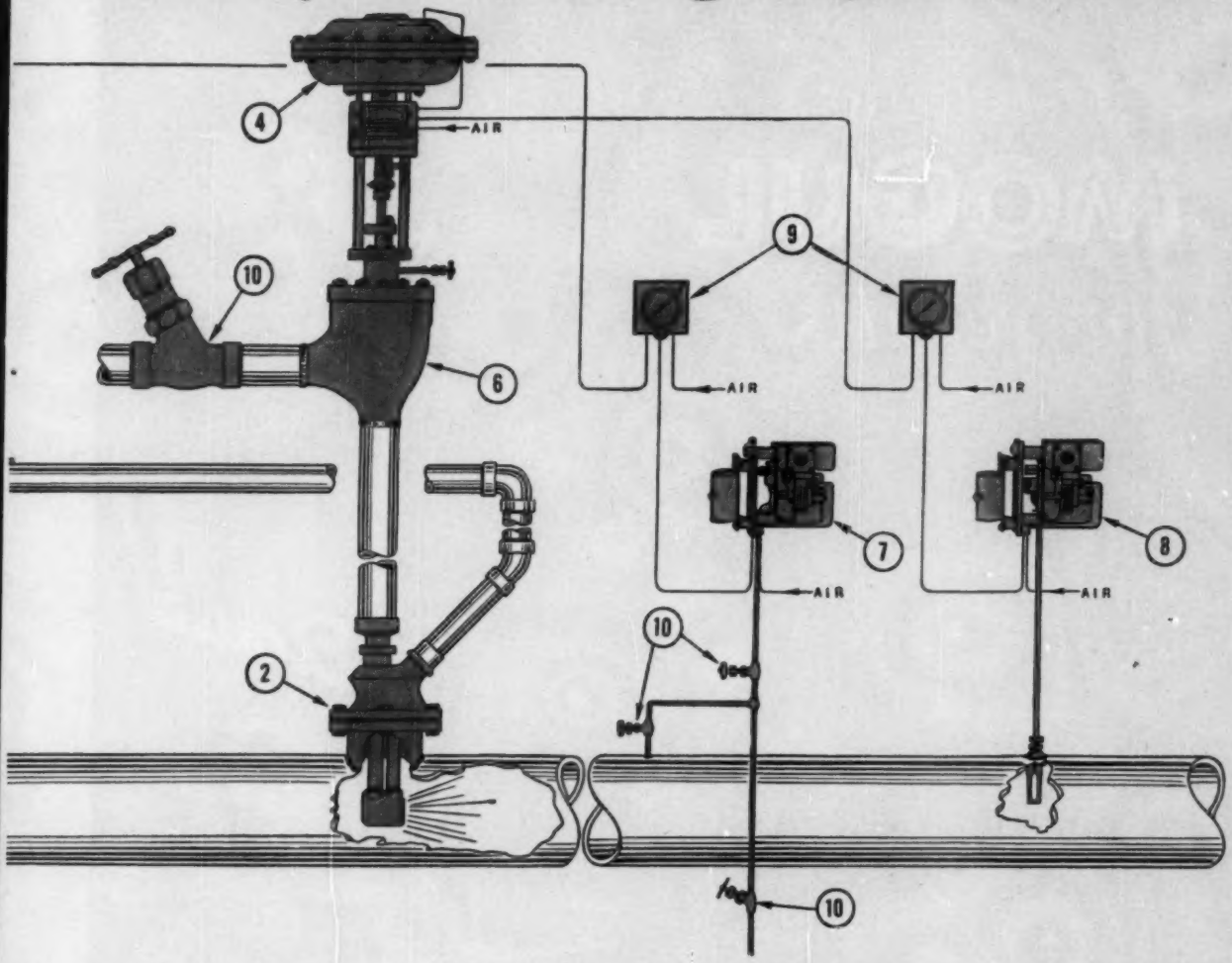

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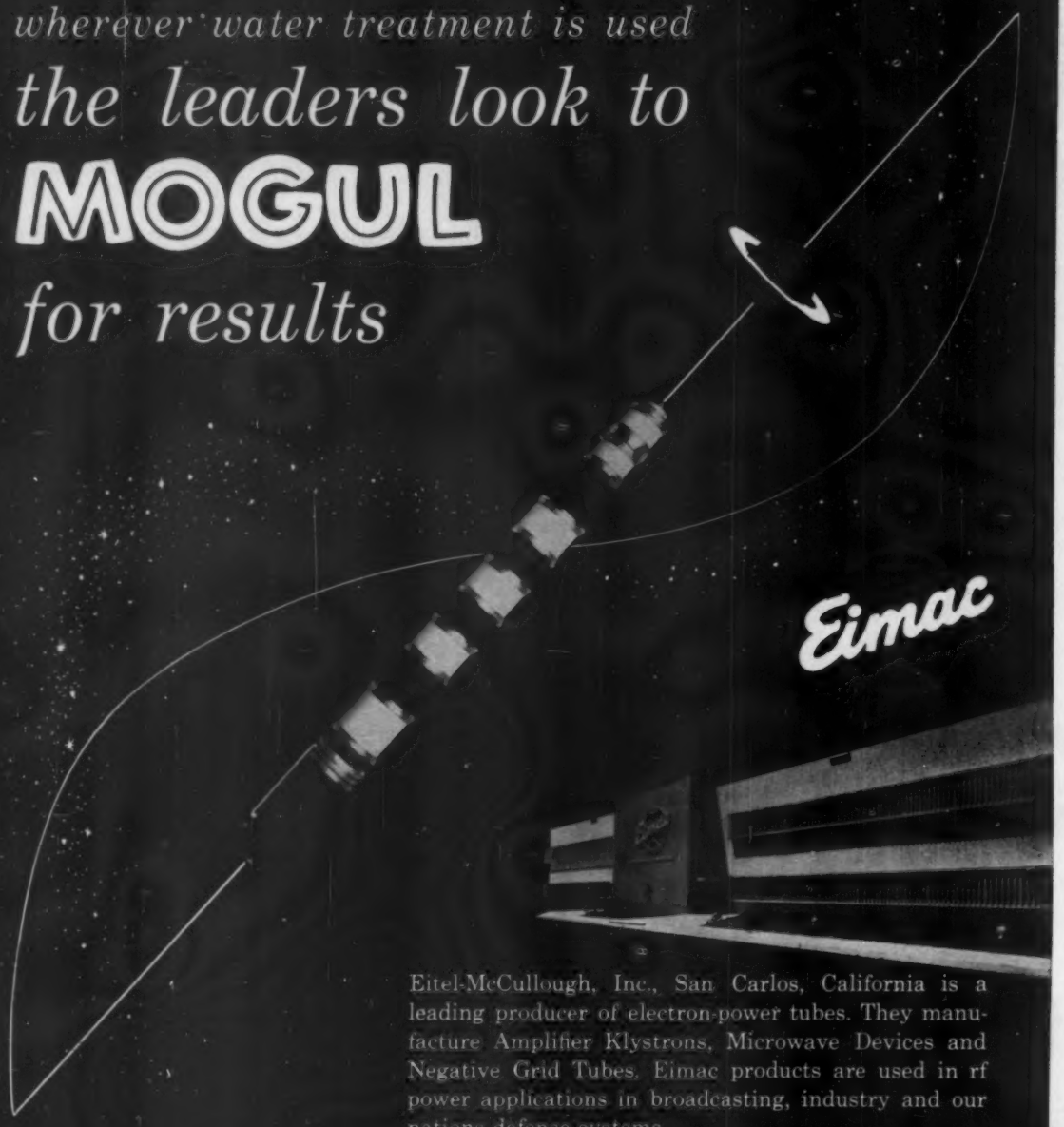

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A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World
Published by Technical Publishing Co.

November 1960

Fission in Retrospect. Looking back over the years, the discovery of nuclear fission late in 1939 seems to have been the almost inevitable and logical outcome of a long series of events and researches that began with the discovery of radioactivity by Becquerel in 1896. The phenomenon of radioactivity as exhibited by the mysterious rays emanating from uranium gave man the first clue to the hidden store of energy in the heart of the atom. This provided the incentive. From that time on the search to tap this store of energy went forward, not always continuously, but in spurts that gradually resulted in the accumulated knowledge and experience that led to the discovery of fission in 1939.

The discovery of fission, however, like many other important discoveries was not as logical and clear-cut as most of us assume it to have been. It is simple to trace the story from its early beginnings with the work of the Curies, through the researches of Bohr and Rutherford, to the discovery of the neutron by Chadwick in 1931, and so, finally, to the work of Fermi, Hahn and Meitner in the late thirties. It is another thing, however, to look at this history more closely, to analyze the findings of these scientists in the light of present knowledge; then it becomes obvious that there were many errors in interpretation, and many important facts were disregarded. This is in no way a criticism of the brilliant men and women involved; it is characteristic of virtually all aspects of human effort. Many important discoveries were delayed because preconceived notions and dogmatic thinking made men blind to the obvious.

This aspect of the discovery of nuclear fission is the subject of a most interesting article in the summer 1960 issue of the (G-E) Research Laboratory Bulletin, by Dr. Leslie G. Cook. As a research student at the Kaiser Wilhelm Institute for Chemistry from 1936 to 1938, Dr. Cook was close to the main characters in the fission story during the critical period. Now, as manager of the Project Analysis Section of the General Electric Research Laboratory, he has a professional as well as personal interest in the histories of scientific discoveries and what they can teach us.

How much the discovery of fission was delayed because of the stresses of the times and their effects in diluting single-minded concentration on the scientific tasks, Dr. Cook does not presume to know. Certain it was; however, he points out, the personal and political stresses in Berlin's Kaiser Wilhelm Institute were severe, and indeed came to a head with the flight of Professor Lise Meitner to Sweden only a few months before the final recognition of fission. Robert Jungk in his book, "Brighter than a Thousand Suns," indicates that similar tensions existed in Rome where Fermi and his associates were doing their work, and undoubtedly the oppressive calm before the conflict had its effects on Paris and in Cambridge. Scientists are people. They do not live in ivory towers. They are usually overly sensitive to the problems and tensions of the world around them. Success in discovery and invention comes not in a cold, calculated, and planned march direct to the goal—as would appear in documents—but rather in sustained, excited, and even feverish, attacks.

Transuranic? Dr. Cook's account begins with Fermi's work in Rome in 1934, where he was bombarding various elements with neutrons from a beryllium-radon source. He found that 47 out of 68 elements which he had examined could be activated by neutrons, and that in nine cases the product elements had atomic numbers within two of the bombarded element. Attention was directed to the special interest in thorium and uranium which "might give rise to successive transformations." With uranium, at least five different periods were discernible in the product-decay curve. One especially, a now notorious 13½-minute half-life activity, was given a thorough check by a chemical method.

This method was to precipitate manganese dioxide with sodium chlorate from a 50% nitric acid solution of the irradiated uranium and observe the activities that came down in the precipitate. To be more certain, various "hold-back" carriers were added to the solution; for example, barium and lanthanum as radium and actinium tracers. Now, since the 13-minute activity was strong in the manganese dioxide precipitate and the mesothorium activities were not, it was concluded that the 13-minute activity was neither radium nor actinium. When most of the elements from lead up to uranium had thus been excluded, Fermi remarked, "This negative evidence . . . suggests the possibility that the atomic number of the element may be greater than 92. If it were an element 93 it would be chemically homologous with manganese and rhenium."

It seems as if this paragraph—as far as the published documentation is concerned—laid down such an attractive scent that its error took over four years to be recognized. Today, with the advantage of hindsight, we know that the 13-minute body was in fact Ba^{141}, clinging tightly to the barium hold-back carrier, a part of which might have been precipitated with the manganese dioxide.

Indeed, the fact that the chemical technique left much to be desired and that an unfamiliar type of atom splitting ought to be considered was documented almost immediately. Frau Ida Noddack, who with her husband, Walter Noddack, had discovered rhenium in 1925, was an inorganic chemist. In a paper in Zt. fur Angewandte Chemie she discussed the Fermi chemistry in explicit detail and concluded that the tests were inconclusive. Then she expressed a startling thought: "One can assume just as well that with these new type nuclear break-ups using neutrons, quite different nuclear reactions occur than one has previously observed using protons and alpha rays. It is possible to imagine that when heavy nuclei are bombarded with neutrons, these nuclei fall apart into several large fragments, which are indeed isotopes of known elements, but not neighbors of irradiated elements."

There, as Dr. Cook points out in his article, was the idea, quite explicitly. But no one else apparently was able to imagine this possibility with Frau Noddack. It was in direct conflict with currently accepted concepts. It would take four more years before continued experiment along the lines of Fermi's suggestion would stumble so hard as to force a test of the Noddack "imagination" as a last desperate measure, and show it to be in fact correct.

It Couldn't Be So. As Dr. Hahn said in his Nobel Prize Lecture in 1946, "This suggestion was at that time not seriously discussed because it contradicted all the physical concepts of nuclear physics."

Fermi was equally difficult to convince. His views are reported by Robert Jungk in his book, previously mentioned. As a physicist, the idea appeared quite impossible to him, above all because Otto Hahn, the best known radium specialist, agreed.

On the 14th and 15th of May 1937, Hahn, Meitner, and Fritz Strassman submitted two papers to the Zt. fur Physik and Berichte der Chemischen Gesellschaft summarizing their findings to date.

In these papers, six of the activities produced by irradiation of uranium with neutrons were identified chemically as transuranic homologs of rhenium, osmium, iridium, and platinum. It turned out later this, too, was a false scent. The elements were not transuranic elements at all, but perfectly well-

known elements. The supposed eka platinum homolog, for example, turned out later to be really iodine.

It is not feasible here to trace in detail the various experiments and the reports of findings of the various investigators in the period between 1937 and the end of 1939, but, despite an accumulating amount of evidence to the contrary during these years, the investigators almost stubbornly refused to admit that the bombardment products were not transuranic. In August 1937, Madame Irene Curie and Paul Savitch submitted a paper to J. Phys. Radium in which they noted the work of Hahn, and stated they had found the same activities. In addition, however, they had found something new. By measuring the decay of irradiated uranium through a 0.5 gram per sq cm filter of aluminum, they had observed, among other things, a striking 3.5-hr activity. As explained by Dr. Cook in his article, this 3.5-hr activity was to play a vital role in the final dramatic events—it was Lanthanum-141 and its half-life was accurate, but of course no one knew either of these things, yet. Curie and Savitch put forth no particular explanation of this new activity, except to suggest possible isomerism in the transuranics.

Curie and Savitch continued their work on this 3.5-hr activity. They effected more refined separations and slowly but steadily began to close in. They had identified the 3.5-hr activity as predominantly rare-earth-like in chemical properties. They had ruled out the natural explanation under the circumstances, that it was the only rare earth near to uranium, actinium; instead they accepted Hahn's chemical work as indicating they were rare-metal homologs, not rare earths; they were left with a puzzle. Later, in another paper, they gave a very detailed analysis of attempts to fit the 3.5-hr body into the Hahn and Strassman scheme of transuranics, and pointed out that there was no obvious way of doing it. In spite of the mounting accumulation of evidence, they held on to the erroneous belief, started by Fermi, that the bombardment products were transuranic.

Time went on, and so did the search for the ultimate truth. Hahn and Strassman, using the Curie and Savitch methods, found the 3.5-hr activity and concluded that the substance could not be a transuranium. Moreover, they reported further astonishing results. In bombarding uranium with neutrons they found three supposed radium isotopes and three supposed actinium isotopes, of which they had been unaware.

Hahn and Strassman believed that Curie and Savitch had had a mixture of these various things, but there was no comment on the Curie and Savitch statement that their 3.5-hr activity preferred to go with lanthanum in an actinium-lanthanum separation—a circumstance which was certainly not compatible. Nor was there any indication of any suspicion in Hahn and Strassman's minds that their roughly 4-hr supposed actinium was too close to the Curie and Savitch 3.5-hr activity for comfort. (We know now that they were identical.)

It was not until late in 1939 that the light finally began to dawn. Hahn and Strassman came to a fateful decision—to give the Curie and Savitch thesis a thorough and proper check, and to actually try out the thesis that Ida Noddack had been able to imagine four years earlier; namely, that they might actually be dealing with perfectly well-known elements far from uranium.

On December 22, 1939, Naturwissenschaft received the fateful paper from Hahn and Strassman. Yes! the supposed actiniums were really lanthanums and the radiums were really bariums. Then, as Dr. Cook tells it, comes the famous paragraph: "As chemists we must, from these experiments, rename the elements in the above scheme, and instead of radium, actinium, and thorium, write barium, lanthanum, and cerium. As nuclear chemists, who are somewhat related to physicists, we cannot yet take the decision to make this big step, which contradicts all the previous experience of nuclear physics. It still could possibly be that a series of rare accidents could have misled us."

In Retrospect. It is obvious now that many scientists realized that they had observed fission in one of its manifestations, but had been too deeply engaged

in a search for something else to notice. Robert Jungk reports Niels Bohr as having said, when apprised of uranium fission, "How have we been able to overlook that so long?"

Today, the concept of uranium fission is so simple even a schoolboy takes it as self-evident. It is salutary to realize that a scant 23 years ago it was an idea so foreign to then-current concepts that the world's nuclear scientists were not even willing to take time to examine the evidence, let alone perform a few simple critical experiments.

Feet of Clay? It is perhaps somewhat reassuring to us ordinary mortals to find that even the great masterminds of physics and chemistry have at times had the failings of shortsightedness. Actually, of course, what is described here is merely a manifestation of having one's nose too close to the grindstone. For specialists in a given field it is often very difficult to keep an open mind. Too rigid a classification can be a block to creativity. Because the human mind tends to assign a single purpose to every object, we are unlikely to see how we can fit the object into a new use.

The Case of Bakelite. The history of the discovery of Bakelite provides another illustration of this type of mental block. Before Dr. Leo Baekeland discovered the plastic which bears his name, many chemists were at work in an effort to develop a new and better electrical insulating material that could be used in the manufacture of switches, panels, etc. The asphalt compounds used at that time were brittle and generally unsatisfactory.

In the course of the years many chemical combinations had been tried and many different types of reactions studied. Among others, certain reactions involving formaldehyde and phenol were tried but none of them proved successful. The reactions invariably resulted in an infusible, insoluble mass at the bottom of the reaction vessel. Consequently, these unsuccessful end results were discarded and attempts were made in another direction.

Dr. Baekeland, in his researches, also experimented with phenol and formaldehyde, and like the others, he achieved the same infusible, insoluble masses as his end result. Dr. Baekeland, however, was keen to see that the infusible, insoluble mass at the bottom of his reaction vessel was exactly what he was looking for. If only he could control the chemical reaction at some intermediate point, then perhaps he could run his liquids or powders into molds suitable for switch bases or other electrical component parts, and cause the resin to set permanently in a final reaction. And that, indeed, proved to be the solution. The production of Bakelite components involves a primary reaction, used in manufacturing the resins, and a secondary reaction, used in the molding techniques in fabricating finished products. In retrospect, the whole idea is simple enough, but its success depended upon recognizing a use for previously discarded objects.

In view of case histories such as these, one may be tempted, erroneously, to view the histories of major discoveries and inventions almost as comedies of error. As Dr. Cook points out, however, the impressive fact is that it is a truly tremendous accomplishment for the human brain to recognize and face the simplest of facts and concepts which are out of pattern, as indeed are all new discoveries and many new inventions.

Andrew W. Kramer

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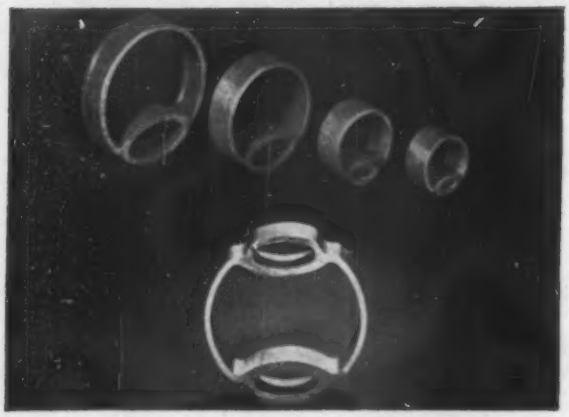

The development of DUOTRACE has opened broad new areas of design exploration in the field of heat transfer. By adding a second trace chamber to the one previously available in UNITRACE, DUOTRACE permits recirculation of the trace fluid. This opens up a whole new area of heat transfer design. Not the least of the possibilities is this: certain types of heat exchangers may now be extruded as single units. The cost savings implicit in such a unit are almost staggering. Alcoa engineers will be happy to assist you in exploring such design innovations in your own plant or process.

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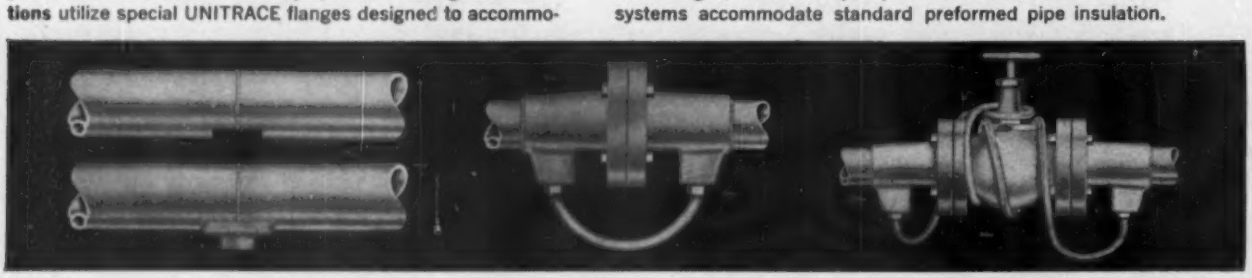
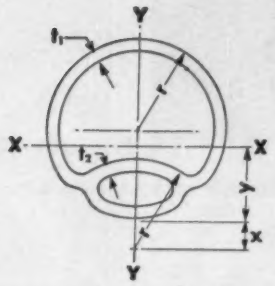
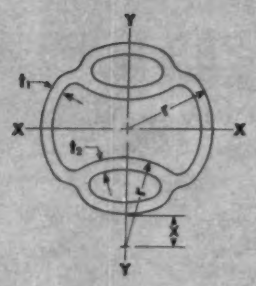


UNFLANGED CONNECTIONS FLANGED CONNECTIONS VALVES AND FITTINGS



	Unitrace Sizes	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
Axis XX	Moment of Inertia (I) in.⁴	.09	.34	.72	2.71	6.52	31.82	81.82
	Radius of Gyration (R) in.	.37	.58	.72	1.09	1.42	2.12	2.78
	Section Modulus (S) in.³	.13	.34	.56	1.42	2.65	8.73	17.22
Axis YY	Moment of Inertia (I) in.⁴	.09	.33	.70	2.65	6.36	29.72	76.70
	Radius of Gyration (R) in.	.37	.57	.71	1.08	1.40	2.05	2.69
	Section Modulus (S) in.³	.14	.34	.59	1.52	2.83	8.97	17.79

Sizes	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
r	.657	.950	1.187	1.750	2.250	3.312	4.312
t_1	.133	.145	.154	.170	.187	.280	.322
t_2	.145	.163	.174	.185	.200	.307	.354
x	.133	.344	.406	.625	.813	1.500	2.000
y	.61	.87	1.08	1.59	2.03	2.98	3.87



	Duotrace Sizes	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
Axis XX	Moment of Inertia (I) in.⁴	—	—	.80	3.06	7.53	—	—
	Radius of Gyration (R) in.	—	—	.74	1.12	1.46	—	—
	Section Modulus (S) in.³	—	—	.68	1.75	3.35	—	—
Axis YY	Moment of Inertia (I) in.⁴	—	—	.67	2.59	6.29	—	—
	Radius of Gyration (R) in.	—	—	.68	1.03	1.33	—	—
	Section Modulus (S) in.³	—	—	.57	1.48	2.80	—	—

Sizes	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
r	—	—	1.187	1.750	2.250	—	—
t_1	—	—	.154	.170	.187	—	—
t_2	—	—	.174	.185	.200	—	—
x	—	—	.531	.843	1.125	—	—
y	—	—	—	—	—	—	—

Unitrace-Duotrace Sizes	1 in.	1½ in.	2 in.		3 in.		4 in.		6 in.	8 in.
Product Area (in.²)	.64	1.68	2.72	2.36	6.38	5.67	10.84	9.74	24.64	42.79
Trace Area (in.² each)	.10	.16	.35	.22	.98	.61	1.86	1.07	2.85	5.12
Metal Area (in.²)	.65	1.03	1.39	1.46	2.28	2.46	3.24	3.53	7.05	10.60
Weight (lb/ft)	.77	1.22	1.66	1.72	2.71	2.89	3.85	4.16	8.38	12.60
*Min. Bend Radii (in.)	5	8	10½	10½	17	17	24	24	36	48
Wetted Perimeter (in.)										
Product	3.35	4.92	6.31	6.28	9.68	9.65	12.72	13.02	18.63	24.75
Trace (each)	1.49	1.71	2.40	1.87	4.13	3.22	5.32	4.23	6.75	9.63
Fitting Weights (lb)										
Trace-Caps	.102	.126	.240	.13	.464	.40	.674	.55	1.67	2.92
Elbows	.706	1.347	2.111	2.65	5.244	6.59	9.649	11.68	27.76	52.51
Impingement Plates	.024	.039	.057		.101		.162		.22	.34
Stub Ends				.65		1.50		2.13		
Terminal Casting				.50		1.12		1.75		

	1–2 in.	1½–2½ in.	2–3 in.	3–4 in.	4–6 in.	6–8 in.
Adapter Flanges	2.419	3.816	4.774	7.216	11.106	19.23

(Note: UNITRACE values are indicated in clear areas in the table above. DUOTRACE values are shown in the shaded areas.)
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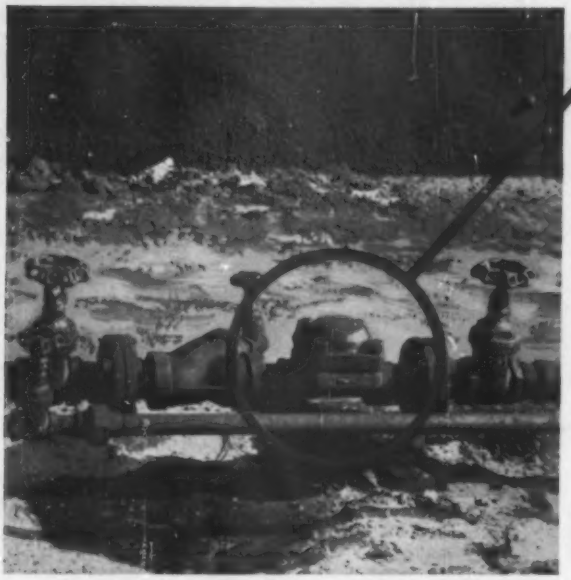

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THIS WE ENDORSE

We feel that hearty congratulations are due Clarence H. Linder, president of AIEE, for his very sensible — and courageous — stand on unified meetings for technical societies. As these groups get larger, and more numerous, it becomes ever more difficult (and expensive) for engineers to acquire their technical information needs. Some men must attend two, three or more technical society meetings — just to "cover all bases."

Manufacturers incur heavy expense in exhibiting, and entertaining, at all of the many conferences and shows held by technical societies. In fairness to them, something should be done to help reduce this expense. Clarence Linder has proposed that special-interest groups — in all societies — find ways of promoting conferences which best serve their purpose.

The recent Power Conference in Philadelphia proved conclusively that joint sessions are of greatest value to power engineers. In this case, AIEE and ASME combined their activities into an excellent conference. Mr. Linder spoke to this group and suggested that members should actively promote a policy of joint meetings, and recommended that action come from them.

Again, at the fall meeting of AIEE in Chicago, Mr. Linder mentioned this point. We believe that it takes a great deal of courage for the head of one technical society to make such recommendations. There are always those in one society who would be opposed to any "merging" activity with another society. We endorse Mr. Linder's proposal, and strongly recommend that all society members give it some serious thought.

Bob McCaw

EDITOR

UNION ELECTRIC'S TAUM SAUK PUMPED-STORAGE HYDRO PLANT

EXECUTIVE VICE-PRESIDENT GEORGE P. GAMBLE DESCRIBES

THE DEVELOPMENT OF THIS OUTSTANDING PEAKING-POWER PROJECT

A TEMPERATURE-SENSITIVE electric system, with wide variations in daily and seasonal demands, does not require that all new generating capacity be capable of high load-factor, low unit-cost operation. If an economical method could be found for providing new capacity which would be reliable and flexible, it is obvious that an occasional low-load-factor unit (or plant) might be an advantage to such a system.

Pumped hydro storage appears to be one way of meeting this need on some electric systems. And, the development of a reversible pump-turbine, capable of pumping in one direction of rotation, and of generating in the other, considerably improves the likelihood that economically attractive plants of this type can be constructed.

Basic principle of pumped hydro storage is not new. There are numerous installations abroad and some in this country. Simply defined, pumped storage makes use of electric energy (generated by prime units during off-peak hours) to pump water from a lower-level pool or lake to a higher pool, then using the water stored at the higher level to operate hydroelectric generating capacity on-peak. Such a plant has load-factor limitations determined by the size and characteristics of the facilities provided, and their relation to the electric system of which it becomes a part. Approximately 3 kwh of off-peak energy must be supplied to provide 2 kwh of on-peak energy.

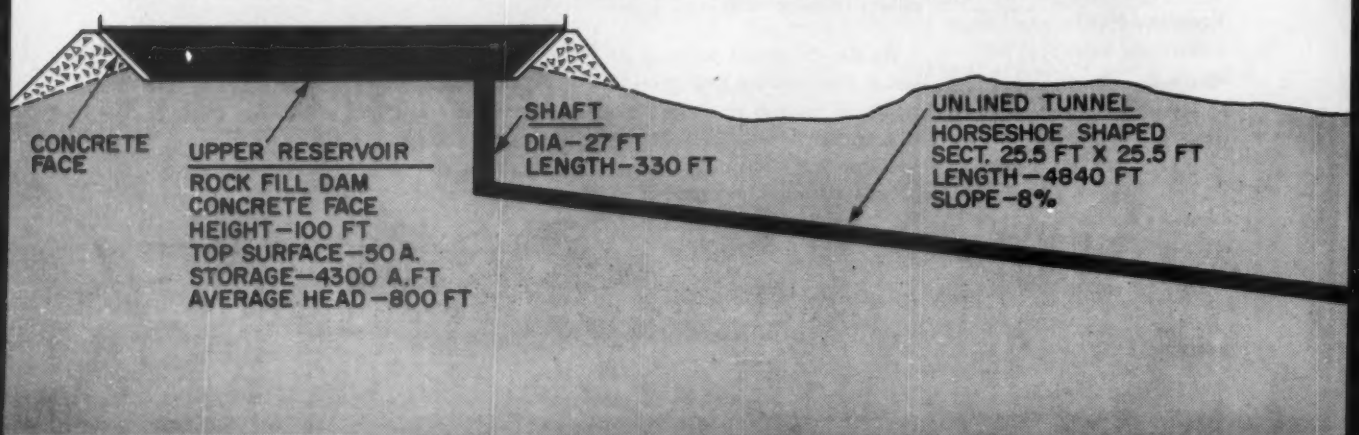
In the fall of 1953, Union Electric Co undertook the study of pumped hydro storage. An exhaustive analysis of competitive means of providing peaking capacity was not undertaken, although several alternatives were considered. Pumped hydro offered an opportunity for mass production of power, by large units connected to the transmission backbone of the system. Also, it would permit load-factor improvement of the large, high-pressure, high-temperature, high-speed, inherently high load-factor thermal machines installed, and to be installed, on the system. These and other factors, including manpower considerations, seemed to justify this approach.

Our first move was to investigate a possible plant on the Lake of the Ozarks, above the Company's Bagnell Dam and Osage hydroelectric plant. The 1300 miles of shoreline of this lake, lying in hilly country, seemed to be ideal for such a project. A site was found which afforded a head of some 160 ft. This seemed quite good, in comparison to the 40-ft head at Keokuk — and the 100-ft head of the Osage plant itself. A rather large upper lake could be formed, which would hold enough water to provide substantial reserve and allow operation on a *weekly pumping cycle* basis, thus not necessarily restoring each night all the energy drawn down the preceding day.

On this basis a plant of some 300 to 500 Mw could be built. However, study brought out the fact that this would not be an economical installation. This was due, primarily, to its great distance from St. Louis, the 30-ft operating variation in the Osage lake level (for which allowance must be made), and the size and cost of hydraulic machinery and structures required for large capacities at this head.

By employing U. S. Geological Survey maps almost every possible site in the general vicinity of St. Louis was appraised. Some six or seven were studied rather fully, to see if a more economical installation could be made than had been the case on the Lake of the Ozarks. Heads of 300 ft or better were being explored, primarily with earth dam construction for the full height. However, some sites were studied at which 300-ft heads could be obtained by building a 200-ft high earth dam in one watershed, and connecting it by aqueduct to a plant in another watershed a few thousand feet distant.

All of these possibilities involved rather large volumes of water, units



Aerial view of entire Taum Sauk project, showing present state of construction

generally in the 100-Mw range and multi-unit installations, with provision for future units, some up to plant capabilities of 1000 Mw.

In 1955, it was decided to make a full-dress engineering study of the most promising of these possibilities, a site on Establishment Creek, in St. Genevieve County, Missouri. The Bechtel Corp of San Francisco was engaged to make this study, working with the Union Electric organization. Surveys, test borings and geological investigations were made. Dams, hydraulic structures and powerhouse were designed in sufficient detail to permit estimates of cost. Some $350,000 was spent on this analysis.

Geological deficiencies in both pool areas, and the high value of farm land inundated by the lower pool, were found to weigh heavily against this project. The situation was further complicated by plans for a national highway to cross the project area, plans which had not been known at the time when the study was initiated.

Immediate proximity of the lower lake to a town also loomed larger as the operating characteristics of this lake became better understood. The fact that an ultimate installation of over 750 Mw would be required to produce a satisfactory cost per kilowatt, and the resultant heavy charge for excess facilities during the intervening years, combined with the above basic handicaps to produce an uneconomical result. On this basis the project was abandoned.

By this time a number of thoughts were developing. It was becoming evident that such projects could not afford the luxury of large lakes with substantial reserve storage capacity. Also, that should a project use the large-lake concept, it would be limited to a head of about 300 ft, since the volume of a fill-dam will vary as the cube of its height. This would be true, unless the two watershed idea were successfully developed or some very unusual topography were found.

Fill-dams, rather than masonry, must be employed for economic reasons. These considerations led to the conclusion that all major factors must be quite favorable, before an installation employing a straight earth-fill dam would pay out on a pure pumped-storage project.

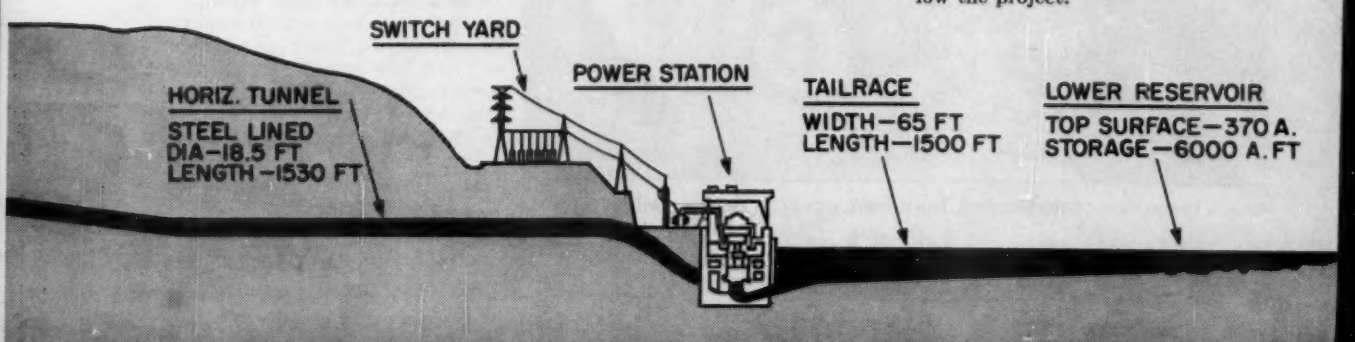
It was also quite evident that if the initial installation at a site does not produce a satisfactory unit-cost, future potentialities will rarely justify the project. This would not mean, however, that if a company, or system, could absorb an initial installation of about 1000 Mw or more (with little present expense for future additions), that a 300-ft earth-fill dam job might not be justified — if the terrain were friendly and the plant well located as to transmission. This would be especially true if the site had some *firm capacity*, as in a conventional hydroelectric development.

With this background, the broad specifications for an economical pumped-storage plant began to take shape. High head, with resultant high speed and large electrical capacity; lean reservoirs requiring minimum containment structures; initial installation of entire project sized to fit capacity increments on the system involved; freedom from costly interferences by highways and towns; reasonable proximity to transmission system — all seemed to enter the picture.

Terrain was found in the St. Francois Mountains, about 100 miles south of St. Louis, the geology of which seemed to offer favorable conditions for such an installation. Numerous mountains in this area are formed from solid granite porphyry, and differences in elevation up to 1000 ft are found. Since a high-head plant, of the size and type then being contemplated, would require relatively little water, a small stream would suffice to make such an installation practical.

The East Fork of the Black River, with minimum flows of under 5 cfs, was found to be entirely adequate for a 350-Mw plant. The minimum flow of this stream, in the driest year on record, would fill a satisfactory lower lake twice. After the initial fill, the only loss would be from evaporation and seepage; hence the normal flow of the river could be maintained below the project.

Schematic diagram below shows main features of this true pumped-storage project



A number of arrangements and possibilities at this site were studied. Finally, it was decided to do a complete preliminary engineering job on what seemed to be the optimum arrangement. This would employ an upper reservoir — formed by blasting off the top of a 900-ft high mountain, and piling the rock thus obtained into an elliptically-shaped dike, or dam, about one mile in circumference and 100 ft high, lining the inside to hold water.

In this manner, 4000 acre-feet of water would be contained, at an average head of 800 ft, in an area of 50 acres. Some 2,750,000 kwh of energy would be contained in this pool, of which 2,200,000 would be used in a normal full day's operation.

A small dam would impound the lower pool in the East Fork of the Black River. This pool would have an area of 370 acres and a total volume of some 5900 acre-feet. (This would be only 0.3 of 1 per cent of the water required to fill the Lake of the Ozarks.) In a full daily cycle of operation, this pool would fluctuate 15 ft in level. A 350-Mw plant rating could be maintained at day's end. The site selected was 30 miles from an important system transmission junction.

Sverdrup & Parcel, Consulting Engineers of St. Louis, were retained to refine the structural and civil engineering features of the basic design developed by our own engineers, including a construction estimate of the entire project, less transmission.

Importance of the faced rock-fill dam to the project's economy and reliability led to an arrangement to secure the assistance of Mr. J. Barry Cooke, Supervising Civil Engineer of Pacific Gas and Electric Co, in the preliminary examination of the project. Mr. Cooke's experience with the structures of that type built by Pacific Gas and Electric Co was an invaluable aid in the early planning.

After the project had been authorized, Mr. I. C. Steele, Consulting Engineer of San Francisco, was retained for further consulting services for the rock-fill dam, and other features.

Sverdrup and Parcel retained Dr. Frank Nickell, Consulting Geologist of San Francisco, on the preliminary report phases of the work, and later in connection with final design.

Under the direction of these consultants, a program of exploratory borings was carried out, which established the geological and physical feasibility of the project. Some $250,000 was spent on engineering studies and estimates, and on the acquisition of lands which would be required for the project, including the mountain itself.

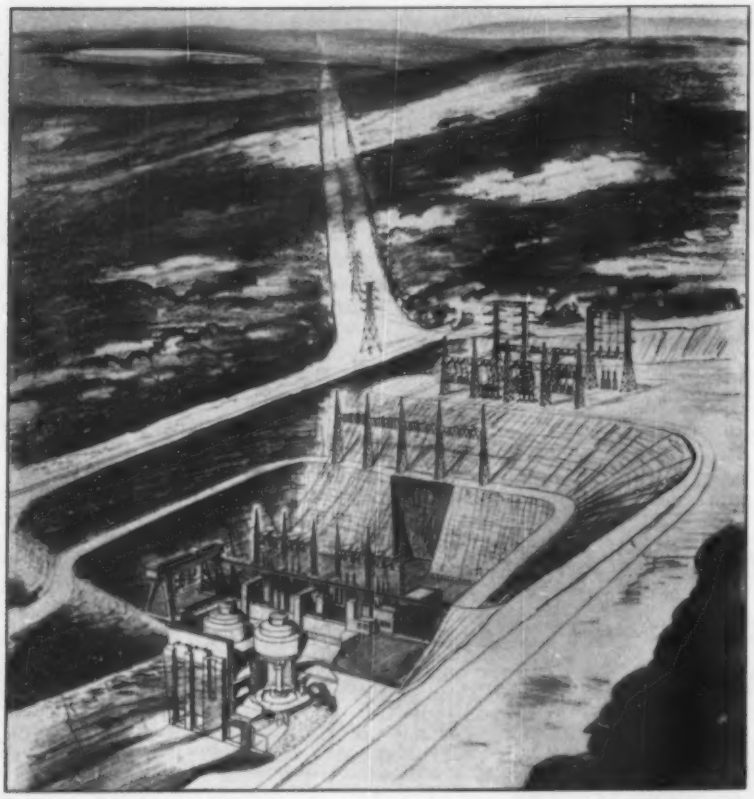
As a result of this work, it was clear that a sound type of pumped-storage development for this system had been found. Extensive economic studies had been in progress for some time; and when the estimated figures became available, the financial results were ascertainable.

Unfortunately, it was not conclusive from these figures whether it would be preferable to go ahead with this project as the next step of system capacity, or to defer it some 6 to 8 years, until another favorable point in the construction cycle was at hand. In other words, should it be delayed until it was again necessary to start a new steam power plant at a new site? Installing the initial unit at a new site always represents a particularly expensive capacity step, an advantage to pumped storage which had not been overlooked in the economic studies.

Late in the summer of 1959 it became imperative to reach a decision as to whether to construct or defer. It was recognized that little would be gained technically by deferring the pumped-storage plant. On the other hand, it was realized that by deferring the steam plant, a somewhat larger steam unit addition on the company's system could be supported, and this larger unit would benefit by the progress of the art during the two- or three-year deferment period.

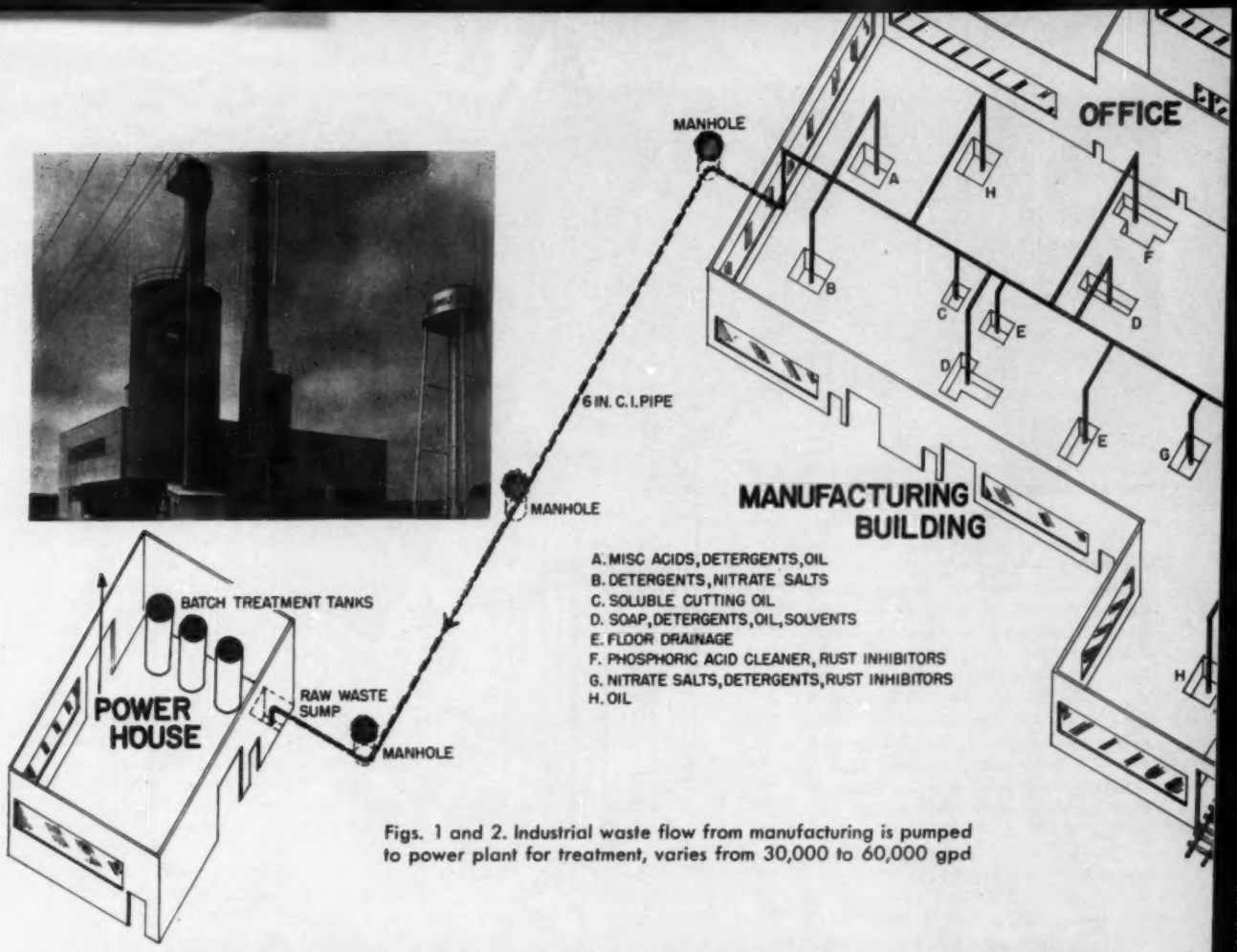
Since, however, the primary factor in the economic justification for pumped storage still lay in the construction cost, it was decided that the only way to resolve the matter was to invite firm bids on the project, including the purchase of major equipment. Company estimates of transmission costs were considered satisfactory.

With the engineering on the project still preliminary, there was a question as to whether firm prices could be obtained. Fortunately, we received four well-prepared offers. The most favorable firm bid was such that a clear decision was possible; and, on December 11, 1959, our Board of Directors authorized the construction of what had then been named the *Taum Sauk Plant.*



Artist's conception of the finished Taum Sauk power plant and switching station

MORE TO COME....



Figs. 1 and 2. Industrial waste flow from manufacturing is pumped to power plant for treatment, varies from 30,000 to 60,000 gpd

POWER PLANT IS CONTROL CENTER FOR WASTE TREATMENT

LINK-BELT'S NEW BEARING PLANT AT INDIANAPOLIS HAS ITS OWN INDUSTRIAL AND SEWAGE WASTES SYSTEM, USES BATCH-TYPE TREATMENT FOR WASTE WATER

BUILT INTO Link-Belt's recently completed bearing-manufacturing plant located on U. S. 36 west of Indianapolis is a complete system for treating both waste water from the manufacturing processes and sanitary sewage. The industrial waste treatment operation has been located in the plant's power house, and is part of the power plant's responsibility.

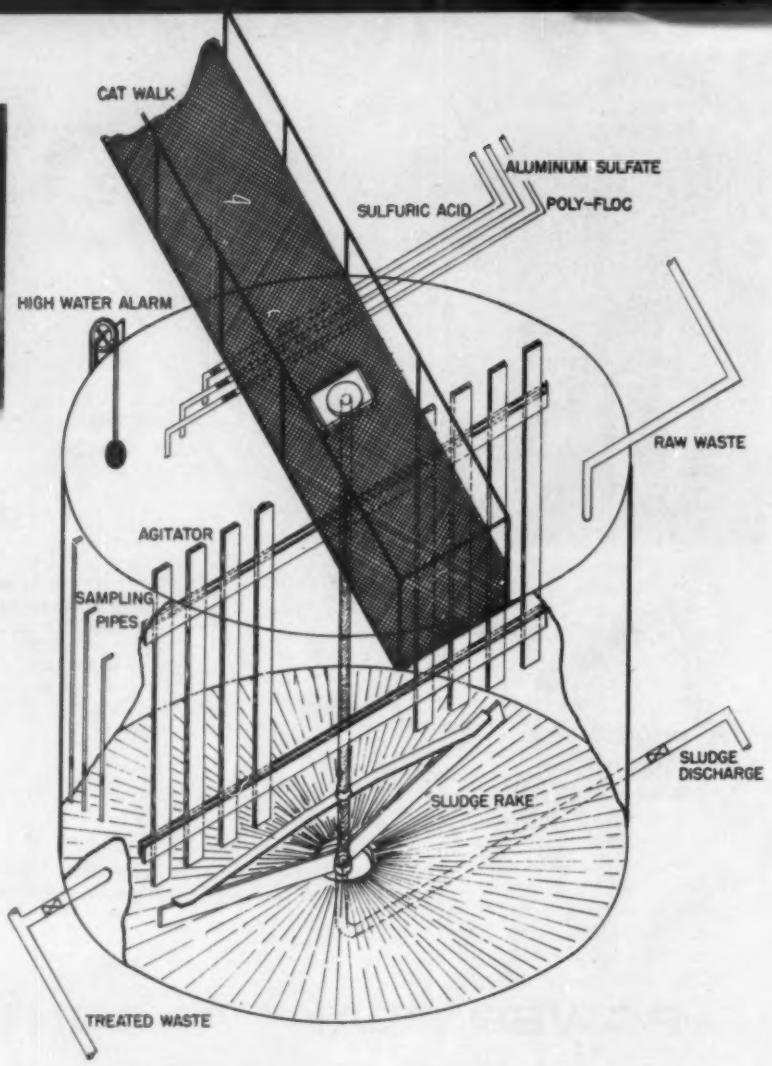
Link-Belt has soundly reasoned that waste treatment involves certain observations, as well as pumps and valves, which combine well with the operation of boilers and air compressors. Combining the two responsibilities has made a compact, very workable arrangement at the Indianapolis plant, and one which is easily expandable. The combined operation is carried out by a power engineer and assistant working as a team under the bearing plant's engineering department.

First, a brief description of the power plant, which generates process steam and steam for heating. Positioned about 400 ft from the manufacturing building to allow for expansion without interrupting product flow, the power plant is a clear span structure 9200 sq ft in area. Construction is of precast concrete lower side walls and roof deck slabs with transite siding above windows. All accessory power plant facilities, treatment systems, pumping stations, and water storage are either attached or installed adjoining.

The plant houses two 30,000 lb-hr, 100-psig, chain-grate, stoker-fired boilers, Fig. 6. Coal-handling system is Link-Belt's own, and conveys and recirculates fuel from an unloading pit to a double shelf 450-ton capacity concrete silo. Traveling weigh lorry transfers coal from silo to boiler feed hoppers. A pneumatic conveyor removes ash from boilers into an elevated ceramic silo.

Lime soda hot process softener and a deaerating heater treat boiler water, which is supplied through either an electric-driven or steam-driven feedwater pump.

There are two 1100 cfm at 100 psi, double-acting, 2-stage water-cooled air compressors; also, two 1000-gpm fire pumps, one electric driven and one diesel driven.



Figs. 3 and 4. Three waste treatment tanks in power house are 33,000 gal each, are equipped as shown. There are also two oil-holding and settling tanks

The power plant also houses a chemistry laboratory equipped to analyze and test for power plant, wastes treatment system and the manufacturing operational processes.

The industrial waste treatment is located in the north end of this power plant and is a batch-type for ease of operation with the bearing plant's type and range of waste flow (see Fig. 1). The flow is almost always alkaline, with the characteristics of flow varying quite widely from day to day.

The industrial waste system consists of three 33,000-gal treatment tanks (Figs. 3, 4 and 7) which are equipped with mixers, skimmers and drawoffs for sludge and treated effluent. Also, the system has two 5500-gal, cone-shaped oil-holding and settling tanks, which are provided with drawoffs for both water and oil. Provision also has been made to pump this salvage oil to the boilers. As Larry E. Geyer, of the engineering staff, describes this system's operation:

From the raw waste sump in the northeast corner of the power house, the waste water is pumped overhead and into one of the treatment tanks by one of two pumps. These pumps operate on a float control supplemented by an alternator. When one of the treatment tanks becomes full, the flow of raw waste is routed into another tank and the full tank is skimmed. The skimmings are pumped into one of the oil-holding tanks.

After the treatment tank has been skimmed, the mixer is started and sample of the waste contained in the tank is drawn. A jar test is then run to determine the amount and type of treatment needed. Because the wastes normally consist of alkaline oily material, variable amounts of sulfuric acid, aluminum sulfate, and a non-ionic polyelectrolyte (poly-floc No. 3) are used. In the case of water-soluble oils, sodium carbonate and lime are added, prior to the regular treatment.

After the mixer is stopped the floc settles on the bottom of the tank, and this sludge is drawn off to one of two industrial waste lagoons. This is done only after the tank has been checked for final pH and visual clarity.

The industrial waste lagoons are 75 ft square and have 6 in. of gravel and 12 in. of sand covering drain tile, which discharges into the sewage plant. The clear effluent in the batch treatment tanks is drawn out between the sludge and any scum formed, and is pumped to a treated waste sump in the northwest corner of the power house, and from here it flows into the plant's sanitary sewer at a uniform rate over a 24-hour period. The scum is discharged to the waste lagoons with the sludge.

The industrial waste flow varies from 30,000 to 60,000 gallons per day with pH varying from 12.0 to 6.8. The pH on the treated waste effluent will vary from 6.0–7.5. The flow per month averages a total of approximately 1,000,000 gallons.

Complete BOD and suspended solids removal is accomplished after the complete treatment cycle. The pH of the wastes entering the sewage plant will vary from 8.0 to 6.5 depending upon the per cent of treated industrial waste. Chlorine residual on the final effluent is maintained at 0.4 to 0.6 ppm.

Sewage Plant

The plant's sanitary sewer runs underground the east-west length of the manufacturing building, with branches picking up the toilet and drinking water wastes in the manufacturing building and the first and second floors of the office.

Sewage plant, Fig. 5, is of the biofiltration type with two filters in series. Flow can be diverted either through a screen or through the comminutor by changing slide gates in the pit. After comminution the sewage enters a division chamber and is routed by slide gates to the primary settling tank.

This tank is designed for a maxi-

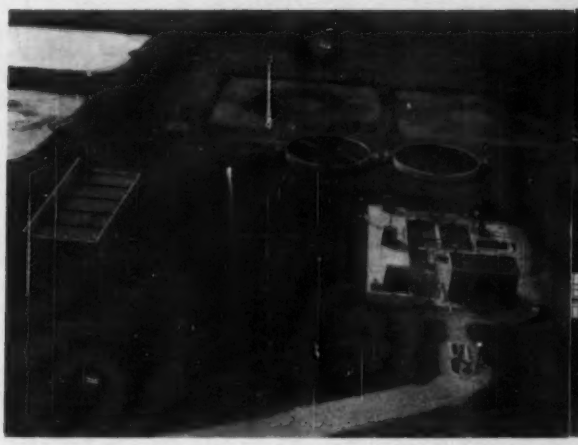


Fig. 5. Sewage plant uses two bio-filters, can handle 330 gpm

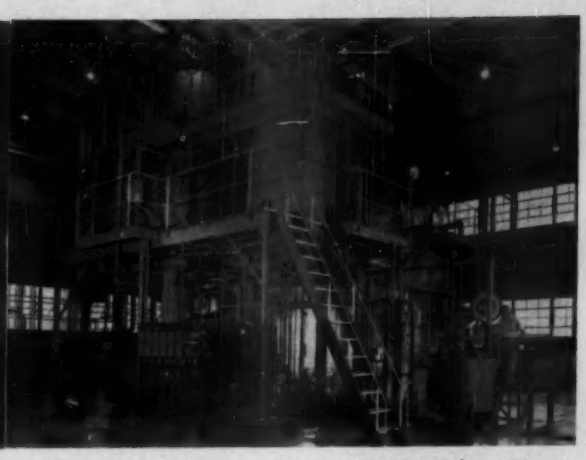


Fig. 6. Power plant's two boilers are 30,000 lb/hr, 100 psig

mum raw sewage flow of 110 gpm or 159,000 gpd, and a maximum total flow of 330 gpm. It is designed for 1.4 hours retention time and 33 per cent BOD removal under maximum flow conditions. It is equipped with a sludge drawoff and a skimmer to discharge scum and sludge to a pit from which it can be pumped by a plunger pump, rated at 25–75 gpm, to the digester. Also, the settling tank is equipped with troughs which carry the primary tank effluent to a sump from which it is pumped into the primary bio-filter at the rate of 220 gpm. Primary and secondary bio-filters are 30 ft in diam and 3½ ft deep.

From the primary filter the flow is routed back into the division chamber where it is mixed with raw wastes and flows back into the primary settling tank. The amount of raw sewage entering the system causes a transfer from the primary filter pump sump into the secondary filter pump sump by means of a weir between the two sumps.

From the secondary filter pump sump the sewage is pumped to the secondary filter; after filtration it flows into the final settling tank through the division chamber. The final tank is the same size as the primary tank, 4320 ft³, and is equipped similarly. With the 220-gpm maximum design flow, a retention time of 2.45 hr is achieved in the final tank.

Just as the raw sewage quantity into the primary tank caused an equal quantity to transfer from the primary to the final tank, so this same amount forces an equal quantity to flow from the final tank into the slow sand filter sump. As the sump fills, one of the dual 1100-gpm pumps, automatically by float control, pumps 5500 gal into one of the two sand filters.

Each filter is 60 ft square with 2½ ft of sand above the drain tile. From the sand filters the filtered water flows into a chlorine contact tank which provides 110 gpm with a 15-min retention time. The digester is unheated, and has a volume of 5780 ft³. When it becomes loaded the digested sludge is drawn off and pumped to one of five sludge-drying beds. THE END

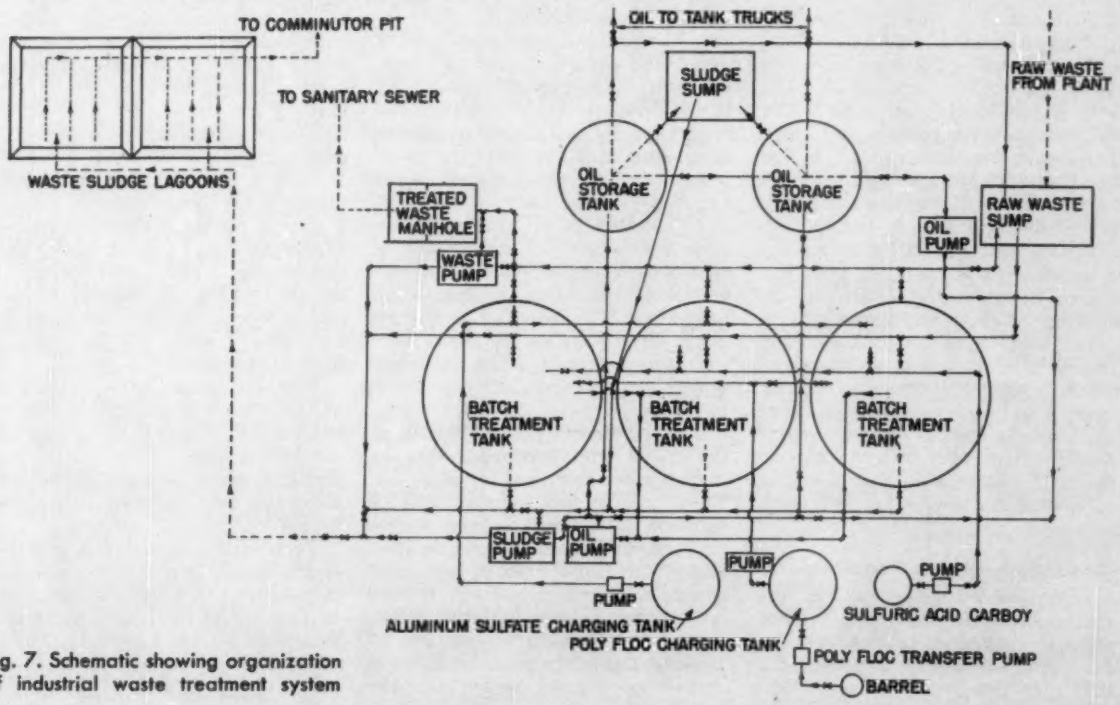


Fig. 7. Schematic showing organization of industrial waste treatment system

MODEL TESTS PROVE DESIGN, SAVE HEADACHES

SCALE MODELS SOLVE UNUSUAL WATER INTAKE DESIGN PROBLEM

K. W. HAMMING OF SARGENT & LUNDY AND CHIEF PUMP DESIGN ENGINEER A. KOVATS OF FOSTER WHEELER TELL HOW OLD SYSTEM WAS PROVED ADEQUATE FOR NEW LARGER UNITS

NEW CONSTRUCTION and modernization of the generating facilities at the Crawford Station, located in Chicago, Illinois, of the Commonwealth Edison Company has posed some interesting and varied problems for the consulting engineers and equipment manufacturers. One of the most unusual was adaptation of the existing circulating-water intake facilities to the new generating units.

First unit of the original Crawford Station was placed in service in 1924, and additional units were added in rapid order until a total of six units with a combined gross capacity of 437,500 kw were installed by 1928. These units were sized: Unit 1, 51,000 kw; Unit 2, 62,000 kw; Unit 3, 52,000 kw; Unit 4, 77,000 kw; Unit 5, 91,500 kw; and Unit 6, 104,000 kw. All units were served by a common circulating-water intake and discharge system taking water from the Chicago Sanitary and Ship Canal.

In 1958, Units 1 and 2 were replaced by Unit 7, a cross-compound machine with 215,000 kw net rating. Units 3 and 4 are now being replaced by Unit 8, also a cross-compound machine but with 305,000 kw net rating. Installation of Unit 8 will be completed in time for the 1961 summer peak.

Circulating-Water Requirements

Improved efficiency of the new units reduces the amount of circulating water required from an original 1.4 gpm per kw to a present-day 0.72 gpm per kw. Little more than half the circulating water per kilowatt is required; so that the same amount of circulating water should support twice the original installed capacity with modern units. The proportion of new capacity to that being removed only slightly exceeds this ratio, and therefore the amount of circulating water is only slightly more than originally required.

However, at certain periods of the year, canal flow is restricted much below plant requirements, which results in recirculation and loss of efficiency and capacity. Average diversion from the lake into the canal system is presently limited to 1500 cfs, approximately this plant's design requirement, but a portion of the diversion is through the Calumet River and Sag Channel and not available at Crawford Station. Flow may also vary widely due to storms and is controlled by gates to meet the demands of sanitation, drainage and navigation. This results in available flow past the station of about 1400 cfs for 75 per cent of the time with some hourly minimums of about 800 cfs.

Two circulating-water pumps, of the dry pit type, were installed in the turbine room basement for each unit. These pumps took suction from a common submerged intake tunnel through individual branch tunnels and elbows, all formed of reinforced concrete, Fig. 1. Discharge tunnel, not shown, is also concrete. Main intake and discharge system was no particular problem since total water quantities remain essentially the same. The problem lay mainly in reusing existing branch tunnels from the main supply tunnel to the individual circulating-water pumps.

Connections Unchanged

It was desirable to keep existing connections rather than redesign, not only for structural economy but also to keep the remaining units in operation during the construction period. No stop log chambers were included in the original design, and temporary bulkheading to isolate a major section of tunnel for remodeling would mean shutting down the entire station. With Unit 7 two 69,000-gpm pumps would replace two 40,000-gpm pumps originally installed with Unit 1. Unit 8 requires four 61,000-gpm pumps in the former location of Units 2 and 3 pumps, originally two at 40,000 gpm, and two at 35,000 gpm respectively. This arrangement is shown by Fig. 2. Branch tunnels which were originally designed for velocities of about 4.5 fps will now have to operate at 7.8 fps.

With low canal levels, turbulence at the branch pump suction connections and air intake to the pumps was considered likely. This was of particular concern because of the open sluice gate pit at each pump as shown by Fig. 3.

Fortunately, canal level is relatively stable due to gate control, although it is subject to small variations due to flow rates, winds and other artificial level control. Lowest level under which the station ever operated was elevation −4 ft 6 in. (Chicago City

Datum), created artificially by gate control to allow passage of large ships under bridges during World War II. When current Calumet River Lock and Sag Channel work is completed, the normal river pool at Crawford Station will be about elevation −2 ft 0 in.

Calculations indicated the feasibility of the proposed arrangement provided that low specific speed pumps of sufficiently high suction lift were used. However, it was believed advisable to make model studies to confirm this judgment and especially to assure that increased water velocity in the branch tunnels did not disturb proper pump operation. Sargent & Lundy outlined the test conditions, and Foster Wheeler Corp, New York, the builder of the circulating-water pumps and condensing equipment, performed the model testing work in their shop, as described below.

Model Studies

For the first studies, conducted for Unit 7, a section of the main intake tunnel and an entire branch tunnel including the open valve pit and elbow to one of the pumps was modeled in one-fifth scale. The model was arranged to represent the second pump from the end of the tunnel. A recirculating pipe maintained flow in the main tunnel past the pump intake to simulate the effects of the first pump in operation. Express purpose was to determine:

1. Flow pattern in intake structure between the main intake tunnel and the pump, and lowest water level at which the pumps could operate without air intake.
2. Pressure drop between the tunnel and the pump.
3. Pressure and velocity distribution at suction flange of pump.
4. Improvements necessary for satisfactory operation of the pump.

Test results showed that even with average river levels, severe air intake to the pump could be expected from the valve pit. However, a short tube in the valve pit, as noted in dotted lines of Fig. 3, eliminated air intake and allowed operation at river levels as low as elevation −5 ft 6 in. Determination of this latter figure required inclusion of a calculated drop from the canal to the branch connection. The tube eliminated a large velocity head loss in the pit, reduced turbulence, and almost completely sealed off the pit except for the space required for the existing sluice gate.

A turning vane was required in the pump suction elbow to equalize flow and pressure distribution at the pump inlet flange, as shown in Fig. 3. With both tube and vane installed, pressure drop between main tunnel and

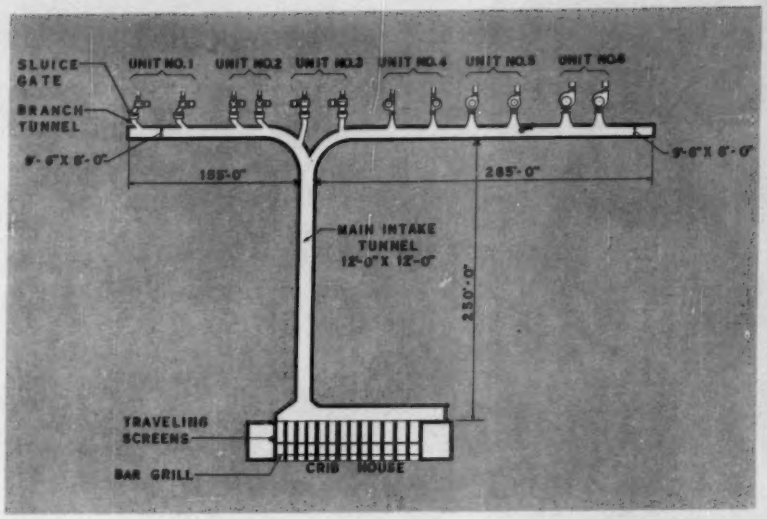


Fig. 1. Circulating-water intake system with connections to the original units

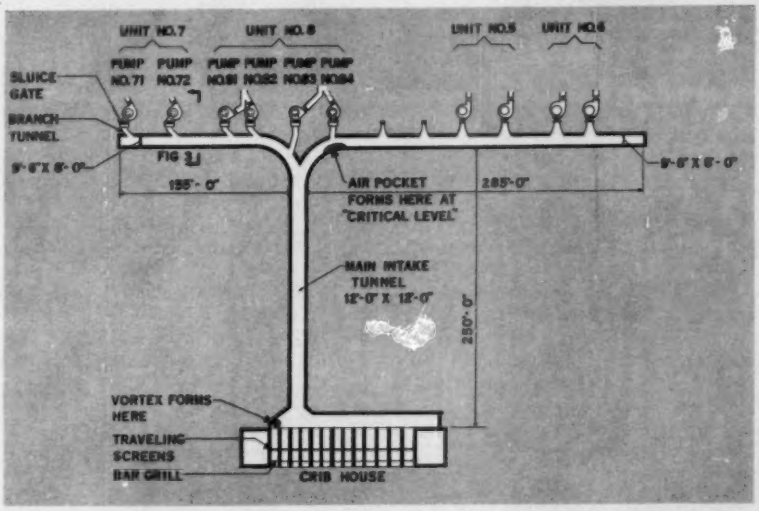


Fig. 2. Circulating-water intake system as it was revised for Unit 7 and Unit 8

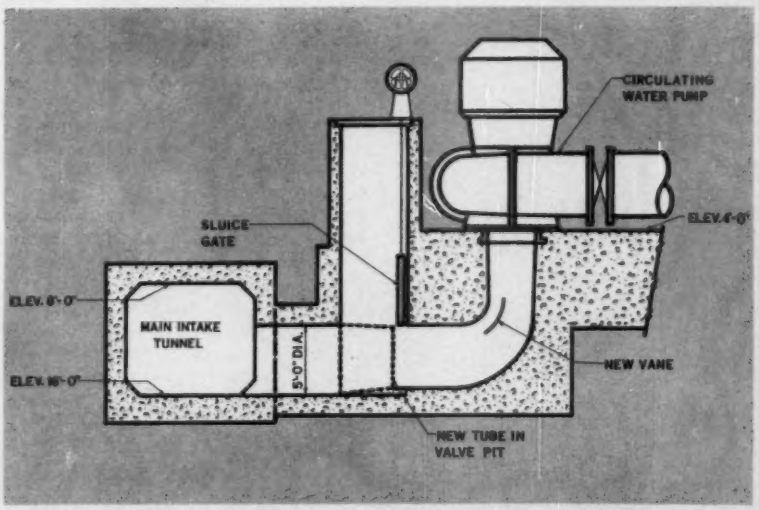


Fig. 3. Typical cross section through the main supply tunnel and branch tunnel

Fig. 4. Model for Unit 8 test; probably one of largest of its type ever made

pump was a minimum, with about 1.0 ft of water head loss.

When Unit 8 was proposed, a much more comprehensive model test of the entire system was desirable. Three of the new Unit 8 pumps will take their suction from one side of the "Y" in the main tunnel, and the fourth pump will take its suction from the other side. It was believed that the pumps directly adjacent to the "Y" would be affected most in that (1) the water velocity past these openings would be the greatest, (2) the branch tunnels to the pumps' suctions were quite long, and (3) the "Y" section would cause velocity effects not readily calculated.

This model was constructed of steel plate and pipe to a 1:6.5 scale. It included the crib house and was complete to the suction of all pumps for Units 7 and 8, as shown in Fig. 4. Floor area required was about 30 ft by 45 ft and was probably one of the largest models of its type ever made.

Model Predicts System Capacity

The large model scale was chosen to match, as closely as practicable, the Reynolds number of the model flow (8×10^5) to that of the actual installation (13.2×10^6). Reynolds numbers so selected are close enough so that the flow patterns obtained in the model can be considered identical to that in the actual installation. Wetted surface of the model had about the same relative roughness as the concrete of the actual tunnel. Six of the seven pumps in the model represented the actual pumps installed with Units 7 and 8, and the seventh was installed on the end of the tunnel serving Units 5 and 6 to simulate the combined flow to these units.

Maximum circulation in the model was 7640 gpm. Each pump had a flowmeter in its discharge line and was provided with a valve for flow adjustment under different test conditions. Tubes and suction vanes, which were determined desirable by the Unit 7 test, were included in this model. Objectives were to determine (1) minimum canal water levels which could be tolerated with various combinations of units in operation, and (2) if unsuspected hydraulic problems existed that might be readily corrected. It was also desired to determine the adequacy of the tunnel system should a future unit be installed in place of Units 5 and 6. Both 325,000 kw and 450,000 kw sizes were considered as possible future units.

"Critical level" was determined by gradually lowering the simulated canal water level in the model until the water level dropped below the top of the intake tunnel at any point, thus allowing formation of air pockets. This level was determined by manometers and plastic windows placed at several points on the model. In all of the tests, the critical level occurred in the main tunnel opposite pump No. 84, the pump nearest the "Y", on the side leading to Units 5 and 6, as shown in Fig. 2.

Level so determined is considered critical because by slight further lowering of the water, air intake to the pump was observed. In the actual installation, the pumps will discharge to the condenser water box under vacuum, and air could be washed in and out intermittently, thus creating a dangerous water hammer as well as loss of capacity. It was interesting to note that, due to velocity effects created at the "Y", the water level in the tunnel is higher on the pump suction side than the side opposite.

Test results were as follows:

Test No.	Units in Operation	Total Flow GPM	Critical Canal Level (Chicago City Datum)
1	7, 4, 5, & 6	526,000	− 5.06
2	7, 8, 5, & 6	696,000	− 4.85
3	7, 8, & future 325 Mw unit	644,000	− 5.02
4	7, 8, & future 450 Mw unit	802,000	− 3.08

As indicated, any operating condition would be possible with the pool level controlled at elevation −2.0. However, other vagaries in pool level control, as discussed previously, make it desirable to design for possible operation with levels at elevation −4.0. Present tunnel arrangement would then not be acceptable for use with a future 450,000-kw unit but would have ample margins for conditions 1, 2, and 3.

Comparison of the gradients measured in the model tests showed good correlation with calculated values, except that calculations could indicate only average gradients at any section in the tunnel. The model, however, showed up the effects of velocity head from side to side of the tunnel. Level readings at the different probes also indicated how much of the velocity head is converted to pressure head when the flow is slowing down due to taking water out of one side of the tunnel by the pumps. This conversion was found to be about 45 per cent efficient.

Summary and Conclusion

Observance of ink injections proved that the original "streamlining" of the tunnel was well conceived and no disturbances in the pump suctions existed. However, a strong vortex formed at the entrance to the intake tunnel, as located on Fig. 2. This vortex did not introduce air into the tunnel in the model which used clean water, but it is possible that it may have a different form when the water contains a high percentage of gas and air as it does in the actual installation.

Attempts to eliminate the vortex by the use of baffles were unsuccessful and major rebuilding would be necessary to effect its positive elimination. If the intake of air from this source should prove to be troublesome, it is estimated that half-foot higher critical water elevations than tabulated would be corrective. A second corrective step, if necessary, would be the sealing of the openings in the crib house floor above the intake section to prevent air intake.

Actual operation of Unit 7 has shown no problem with the circulating-water system. Unit 8 is now being installed and, because the adequacy of the circulating-water system has already been demonstrated in the model, no difficulty from this source is anticipated. THE END

Power Engineering

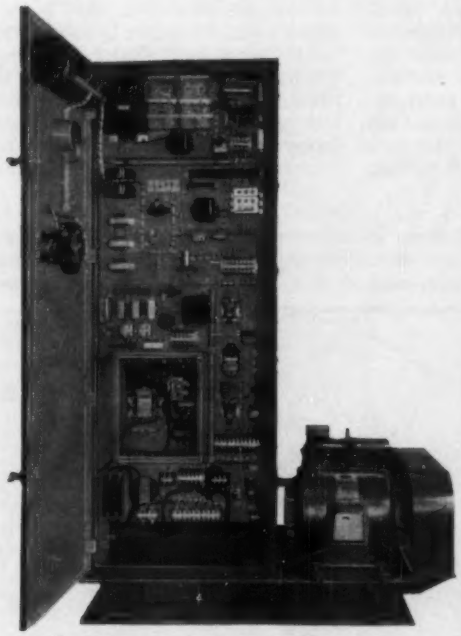
CONTROLLED FREQUENCY FOR RECORDERS

DEVELOPMENT ENGINEER ELTON JACOBSON SHOWS HOW TO OBTAIN FREQUENCY FOR CHART DRIVES WHEN LINE FREQUENCY VARIES

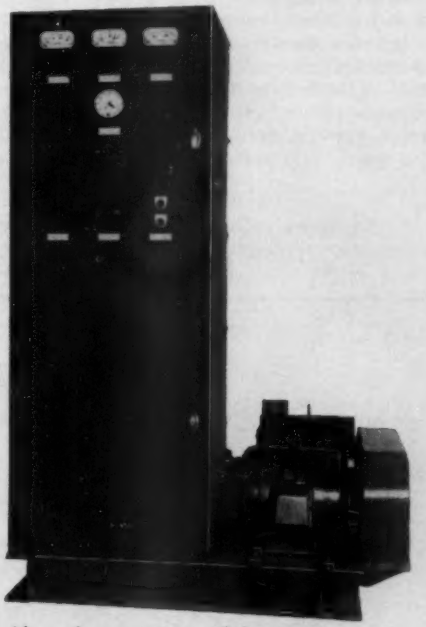
IN SOME LOCALITIES (generally foreign) the available electric power is not obtained at a constant daily average frequency like that of the common utility in the United States. If such power is used to run clocks and chart recorders, indicated time may depart appreciably from standard time after a relatively short period.

This would detract from the charts' usefulness to such an extent that a separate small frequency-control generator is employed to supply the metering power requirements. A block diagram of the constant voltage and frequency set is given in Figure 1, page 66. This paper will be concerned only with the frequency regulating loop.

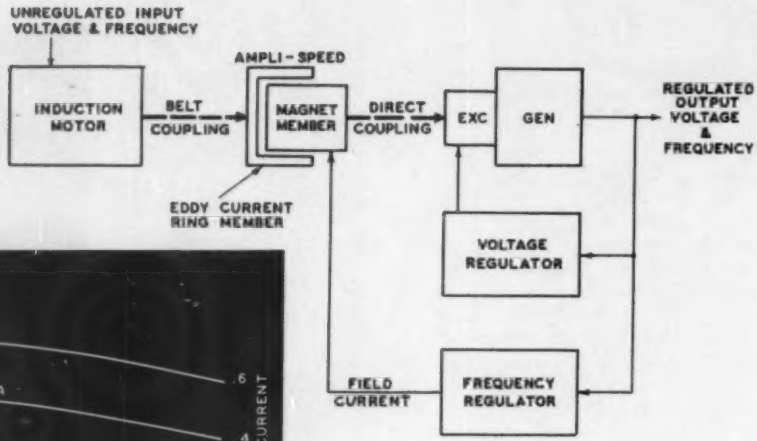
Primary disturbance effects to be minimized are those of input frequency and voltage changes (represented as motor speed changes), tem-

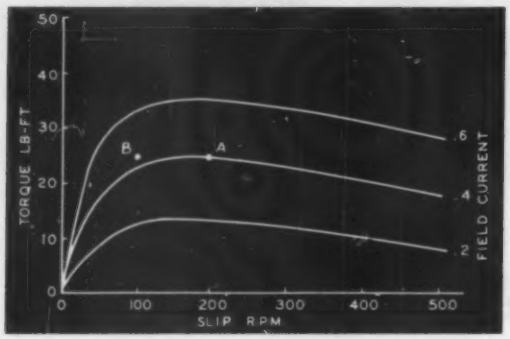


Frequency control unit with door open



Normal appearance of the complete unit





Figs. 1 and 2. Block diagram of control set, and curves showing the slip-torque characteristics of the Ampli-Speed unit

perature variations, and component aging. Motor speed variations are completely absorbed by the Ampli-Speed. Ampli-Speed is the Electric Machinery Mfg Co trade name for an eddy-current magnetic slip-coupling or clutch.

Two independently rotational pieces, a ring member and a magnet member, are mounted in a stationary housing. Torque is transmitted from one member to the other through a separating air gap by interaction of eddy currents in the ring member with the magnetic field of the magnet member. Eddy currents are a function of the strength of the magnetic field and of the relative motion (or slip) between the two members. The magnetic field is controlled with the current in the field coil of the magnet member.

Ampli-Speed's ability to absorb motor speed variations is indicated in Fig. 2 by slip-torque characteristics having field current as the controlling parameter for the family of curves. A typical center operating point might be at A, where 2000-rpm input speed minus 200-rpm slip gives 1800 rpm to drive the 4-pole synchronous generator for 60-cycle-per-second output. A 5 per cent change of input speed, as from 2000 rpm to 1900 rpm, would require a shift in the operating point to B (100 rpm slip) in order to maintain the output speed at 1800 rpm.

This represents such a slight change in the Ampli-Speed field current that the output speed would show a barely measurable transient deviation from 1800 rpm while the control established the new current. If the shift in operating point required a substantial change in field current, the inductance of the field would delay the control establishing the new current and would result in an appreciable transient dip in the output speed.

Frequency Regulator

The frequency regulator consists of a frequency transducer to sense the frequency error and an amplifier to supply excitation to the Ampli-Speed magnet member for error reduction. The frequency transducer is a quad-T network composed of two independent parallel-T, RC circuits (one circuit shown in Fig. 3) tuned above and below the desired frequency.

Frequency input versus voltage curves of the individual parallel-T circuits are plotted in Fig. 3, and the resulting difference of their rectified and filtered outputs is a transfer characteristic of the transducer, Fig. 4. The curve can be shifted in frequency by changing the relative voltage outputs of the two networks.

Variations in generator voltage to the frequency transducer change the slope of the transfer characteristic but not the zero output cross-over frequency (see Fig. 5). It is then important to keep the operating out-

Fig. 3. Frequency transducer circuit and characteristics, showing output voltage as a function of the input frequency for each of the two independent parallel-T tuned circuits

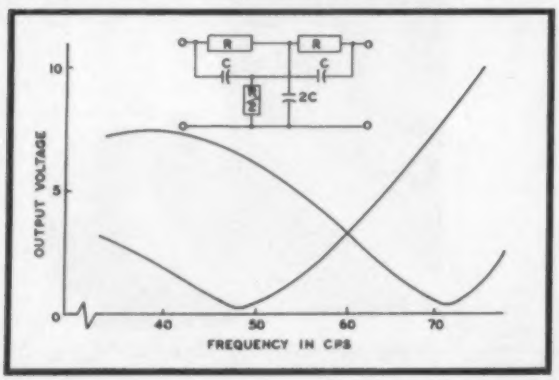
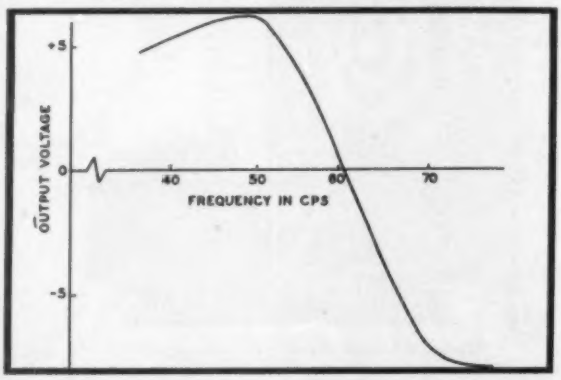
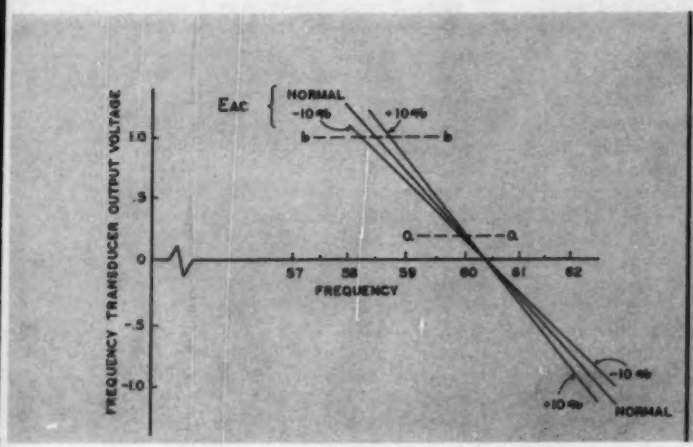
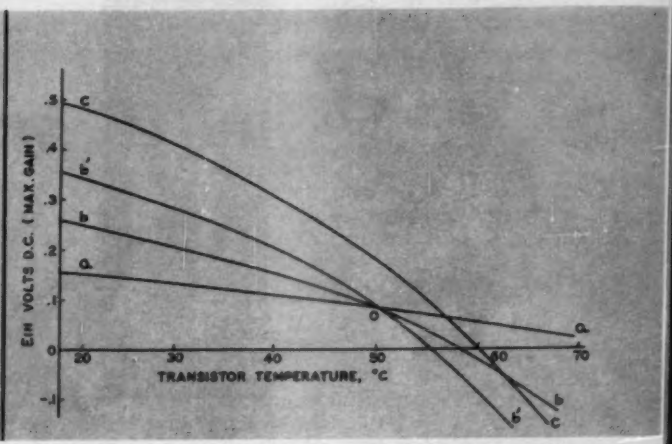


Fig. 4. Transfer characteristic of the frequency transducer, showing the difference voltage of the two independent tuned circuits plotted as a function of the input frequency







Figs. 5 and 6. Changes in generator voltage affect slope of transfer characteristic, but not frequency crossover point. Transducer operating output voltage should be kept close to zero for changes in generator voltage to have minimum effect on frequency. Maintaining d-c amplifier first stage transistor at 55 C level promotes optimum performance

put voltage close to zero if manual adjustments to the generator voltage are to have minimum effect on the frequency. For example: if the d-c amplifier to which the frequency transducer output is coupled requires an input voltage of 0.2 volts to maintain the necessary output, operation will be on the small a-a line of Fig. 5, showing one-fifth the frequency variation versus a-c voltage that the b-b line shows operating at a 1.0 volt d-c amplifier input.

D-c Amplifier

The d-c amplifier is composed of two transistor stages and a magnetic amplifier with an over-all power gain of 90 DB. First-stage transistor is mounted in an oven, which in turn is mounted on a standard octal tube base. The oven is maintained at a constant temperature of about 55 C. Operation of the oven eliminates transistor temperature characteristic variations and reduces the amplifier input operating voltage close to the ideal for optimum frequency transducer performance. Effect of temperature on the input voltage required to maintain a constant output for the first transistor stage is shown in Fig. 6.

Transistor emitter-to-base voltage has the usual 2½ millivolts per degree slope with increase in temperature as shown by curve a-a. Addition of resistance in series with the input results in curves such as b-b and b'-b'. The pivot point, 0, is significant in that no current flows through the series resistor, Rs.

Variation of the input voltage-temperature curves between different transistors is broad. Of four different types checked, the range of "0" was from 37 to 56 C. The range of several transistors of a particular type was about half that, but still enough so that the adjustable parallel resistor, Rp, was added to give control of the operating point without employing an adjustable oven thermostat. The effect of the parallel resistance is a shift of the entire curve to the right, as to c-c.

Enough gain exists in the first-stage transistor to render insignificant the temperature effects of the following transistor and magnetic amplifier stages. Typical curves of the entire amplifier transfer characteristics are shown in Fig. 7, where gain and the first transistor temperature are parameters.

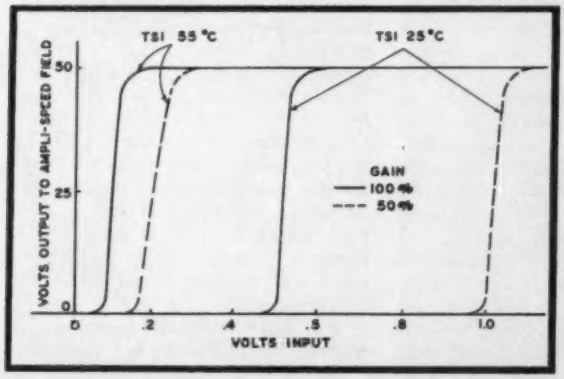
Advantages of operating the first transistor at a controlled temperature are: 1. Changing environmental temperatures will not disturb the operating point; 2. resistance can be added in series with the input for anti-hunt circuits and filters, etc, with little disturbance to the operating point; and 3. the input operating voltage is kept low for good operation with the frequency transducer.

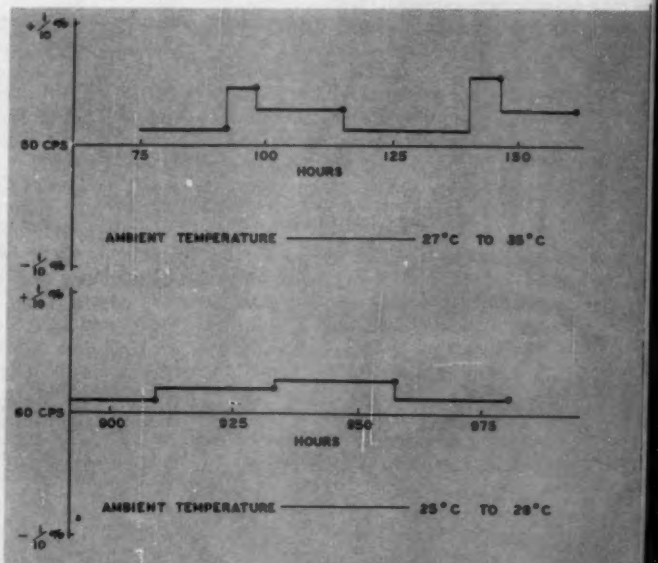
Components that gave most aging

Continued on page 107.

Fig. 7. (Below). Transfer characteristics of d-c amplifier

Fig. 8. Partial results of a test run of 1000 hours duration





HOW RELIABLE IS YOUR PLANT?

J. M. TOTTEN, CHIEF POWER ENGINEER AT STONE AND WEBSTER, TAKES A NEW LOOK AT THE EVER PRESENT PROBLEMS OF PREVENTIVE MAINTENANCE

MAXIMUM RELIABILITY is expected by all steam plant owners, and all plant operators should strive to attain it. If we could disregard economic restrictions, we should have no difficulty in securing maximum reliability. All we should have to do is design the plant to include 100 per cent spare capacity. All equipment would be of proved design, no prototypes, no pioneering; we would have it built by the best talent, staff it with superintelligent, highly skilled men, and then establish and rigidly enforce the rule that nothing would be loaded beyond nameplate rating.

Equipment and construction costs prohibit ever achieving the 100 per cent spare capacity ideal. Continuous pressure for reduction in the cost of power forces us to pioneer. Superintelligent men refuse to work for the wages we can afford to pay. Management usually wants the last kilowatt of capacity regardless of the nameplate or the effect on future availability.

Take a Careful Look

So much we cannot do — what can we do? "Minimize the occurrence of foreseeable or preventable interruptions of service." We do this by preventive action — preventive maintenance specifically being the one important aspect. This requires that we prepare realistic maintenance budgets and vigorously defend them. We also prepare, and attempt to adhere to, comprehensive maintenance schedules which not only provide for a careful look at all vital equipment but also make provision for its repair or rehabilitation.

Another important point we must remember is that "the careful looking" must be done by men who know what they are looking for, can interpret what they see, and can decide what should be done, and how it should be done. If we do not have such talent on the payroll, we are wise to hire it and it is available from many manufacturers' service departments.

Educate the Operator

We have to plan carefully so that the men and the requisite tools are there when needed, and that the stock room contains the requisite spare parts and other maintenance materials. Speaking of materials, we cannot afford to skimp here. We have a right and an obligation to insist on high quality. We should know and avoid the extravagance of reinstalling used gaskets, of using bargain counter hardware and homemade expendables. Expensive labor looms large in nearly all our routine maintenance jobs, with material cost being relatively unimportant.

We must minimize the hazard to reliability arising from operating errors. What are the causes of operating errors? Principally, ignorance, inattention and faulty judgment. Fundamentals of combustion, properties of steam and water, principles of equipment functioning and energy transformation should be familiar knowledge to all operators. We must combat ignorance with education so that every operator knows not only what his equipment should do but also what it will not do; that is, its limitations in all respects.

Operators of high capacity-factor plants seldom have an opportunity to gain experience in the use of remote manual control and in safely transferring the control from automatic to manual and conversely. The operators should have the benefit of this exercise preferably at least once weekly. Emergencies should be simulated and the operators should be instructed and drilled in the correct action to be taken.

Not many years ago, boiler operators were compelled to "fire by the furnace," frequently observing furnace conditions to determine the effectiveness of combustion. This was necessary because they did not have furnace television, oxygen, and combustible recorders and flame monitors. An operator learned "to fire by the furnace," knew how to judge furnace conditions, and could easily detect an unbalance of fuel and air long before it reached serious proportions. Control room experience can never supplant actual front line operating work.

We must always encourage a healthy skepticism in our operators. "Trust all instruments but none too

much," with apologies to Kipling. If two instruments tell conflicting stories, the control room operator must make it his business to find out promptly which one, if either, he should rely on.

Curiosity is another attribute that we should foster. We can be reasonably sure that if our operators are both skeptical and curious, they must be thinking for themselves.

Some plants are being operated so that at times there is only one operator in the central control room. Even in a single-unit station, this is hazardous, foolhardy and inexcusable, at least until someone perfects a "dead man control" for steam power plants.

Another thing that contributes to unreliability of steam stations is the misconception possessed by some operators that the load must be carried at all costs. Rightfully, we should insist that the load must be carried only when it is safe to do so. It is much more sensible to suffer a three- or four-hour interruption and thereby protect the equipment than to risk inflicting major damage and a protracted shutdown measured in days or weeks.

Define Responsibilities

In steam plants, operators' duties and responsibilities must be clearly defined. Definition may be by area, by function or both. If we critically review the log books each day, we can find out to a large extent how responsibilities are being discharged and where responsibilities may require better definition.

Another pitfall we must avoid is "operation by rote." We must make it our business to so educate, instruct and train the operators that we can say with assurance that all of the operators know the "why" of each procedure. "Operation by rote" not only does not suffice when everything operates normally and as it should, but also it can turn an emergency into a disaster.

Employee morale and plant reliability are related, but we have much to learn about exactly *how* they are related. This should not prevent us from trying to establish and maintain a high standard of morale. Good morale usually results when we have succeeded in convincing every employee that he will be dealt with fairly and that competence will be rewarded just as surely as incompetence will be penalized. Fair dealing means also that we will adhere strictly to bargaining agreements and contract terms, that we will be receptive to suggestions, and will hear each employee out on complaints with forbearance and patient attentiveness.

Weather can and does affect plant reliability. The burden of protecting the plant from hurricanes, floods, cloudbursts and extremes of temperature rests chiefly on the designer. As administrators we need good weather forecasts so that we can take precautions such as the draining of exposed lines to prevent freezing, placement of watertight bulkheads and sandbags, and temporary elevation of equipment otherwise exposed to flood waters. In extremely cold weather, freezing of moisture in air lines must be guarded against.

A supply of clean, dry control air is a vital necessity in modern plants. Pressure-reducing valves should always be placed downstream of the air filters and driers.

Recognize Reliability Aids

Many features which we think of as being provided for the convenience of the operators actually contribute to plant reliability. Accessibility to equipment should be provided by permanent stairways, platforms, stiles and ladders. Equipment which is not readily accessible will seldom receive proper attention from the operators and maintenance crew.

Metal labels attached to valves, together with designations boldly lettered on piping, including arrows showing normal direction of flow, save time and greatly assist in preventing errors. More use can be made of padlocks or lead seals to prevent the inadvertent operation of valves or switches which would endanger the operating equipment. As a specific example, the master valve for control air to each unit should be locked or sealed open.

Transparent plastic cylinders placed over important switch handles on benchboards serve as excellent reminders. A helpful design detail is to use dissimilar switch handles for main circuit breaker control and governor speed changer control to avoid operator confusion. Locks or seals, while not protecting against determined saboteurs, do result in thought-provoking pauses on the part of the operators.

Coöperation Is Needed

We should insist on close coöperation between the maintenance and operating crews. The maintenance crew must be instructed to promptly release equipment out of service on a clearance as soon as their work is completed, even before they pick up their tools. The authorization of maintenance work which would impair reliability ever so remotely should be reserved to the plant superintendent.

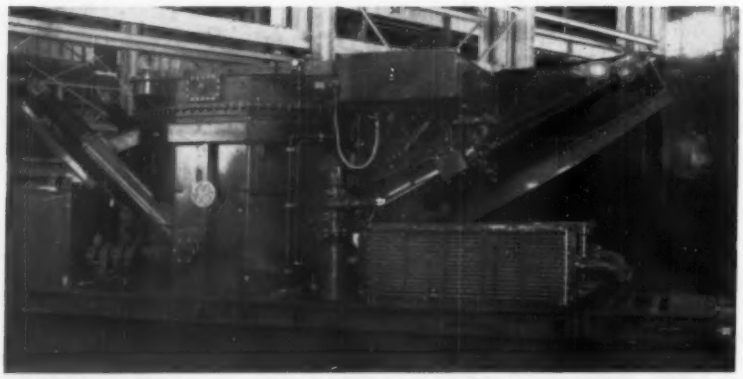
Stand-by capacity worthy of the name must be as reliable as active capacity. Good management requires that such capacity be realistically rated and conscientiously maintained. Rating must be based solely on actual performance as demonstrated by trial operation at six-month intervals or oftener. Trial operation will readily disclose certain needed maintenance, but we should not consider successful intermittent operation as a substitute for thorough inspections according to a well planned schedule.

In summary, reliability being dependent on men and machinery, it behooves us to see that our machinery is kept in first-class condition and that our operators are alert and take pride in what they do. THE END

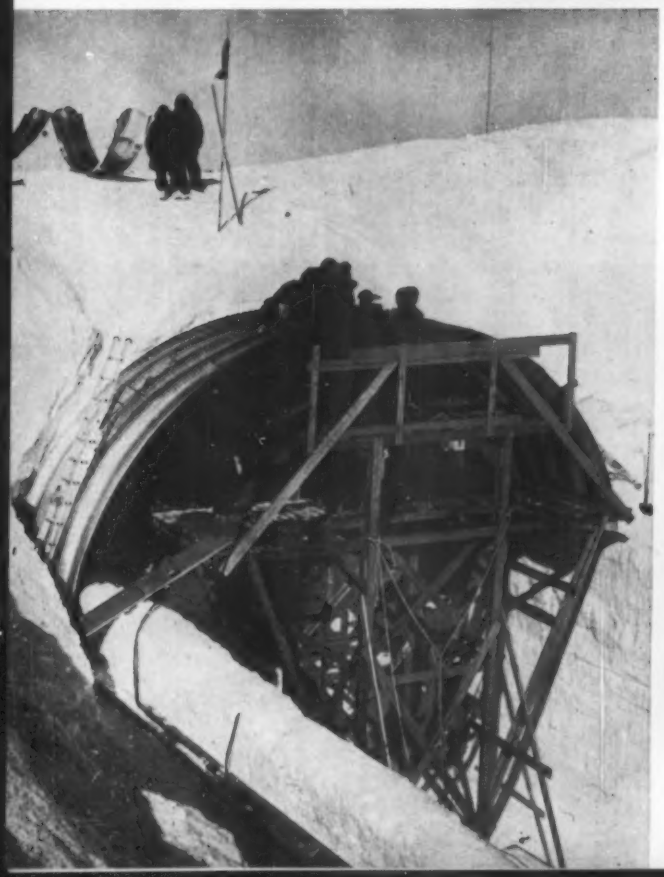
Operator checks instrument board controlling two units in a modern steam plant

Ship YFP-10 is a floating power station for the first Ballistic Missile Early Warning System for North America. Burns & Roe will operate plant, which has 3 boilers supplying 123,000 lb/hr at 650 psig, 830F to three turbines. Lagoon formed by caissons protects ship. Station is featured in POE, December

Power Engineering's

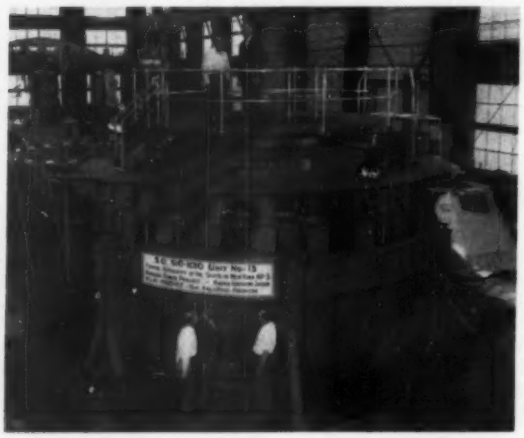


Atomic age igloo is this snow tunnel which is part of system housing a nuclear power plant for Army base on Greenland ice cap. Plant was designed and constructed by ALCO Products



This 40,000-kva, 230-kv mobile transformer was recently shipped by GE to the Pacific Gas & Electric Co. Unit has 32-wheel trailer, with towing tractor will measure 60 ft

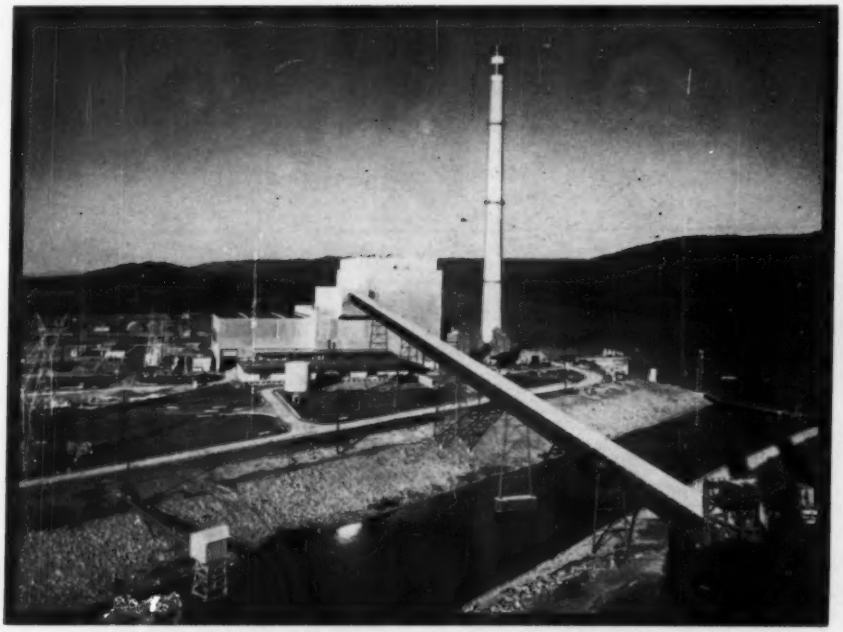
Last of the 13 200,000-hp turbines that will generate 2 million kw of power at Niagara Generating Station. Baldwin-Lima-Hamilton completed the 13-unit job in exactly two years



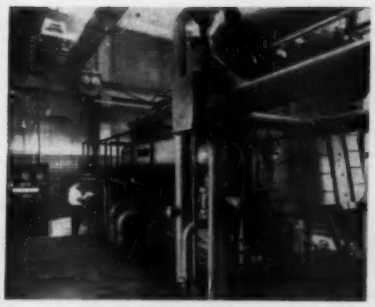
Commonwealth Edison's Dresden, nation's largest atomic power plant, was dedicated in Oct. Full power output is 180,000 kw

NEWS REEL

Experimenting with setting transmission line poles by helicopter, TVA rates method as successful in easing the job on rugged terrain. Craft made 98 load trips, to transport and place 69 poles and 29 rolls of conductor cable, in flying time of 10 hours and 18 min



Widows Creek Steam Plant of TVA on Tennessee River in northeastern Alabama has started up its new unit No. 7, shown here, a 500,000-kw turbine generator. Channel in foreground handles intake water for the condensers. New generator will produce about 4 billion kwh per year



Natural gas industry's first 2-cycle V-type gas engine driving a centrifugal pipeline compressor is this Clark 4000 bhp model installed at the Hampshire, Tenn., station of Columbia Gulf

LARGE-SCALE FUEL ECONOMY PROMISED WITH DISTRICT HEATING

GEORGE RETI, PROJECT ENGINEER, THE KULJIAN CORP,

DESCRIBES ADVANTAGES OF BACK-PRESSURE POWER GENERATION

REMARKABLE progress has been achieved in increasing the efficiency of large power plants, but little is being done to exploit other possible means of large-scale fuel saving. One of the most promising approaches to improving fuel economy is central heating.

Due to the general fuel shortage in Europe, heat economy is much more necessary over there. Our national fuel reserves promise to last longer than those of most European countries, but it is not too early to anticipate future shortages. The time when a significant part of our heat demand can be supplied by atomic fuel is far away. So in the decades to come, the exploitation of our fossil fuel sources will continue, presumably, on the same exploding scale as in the last decades.

In central heating system development our country is far behind most of the European countries and especially Russia, which after World War II rapidly developed her modern and very extensive systems. Obvious reasons for our lag in developing such heating systems include more favorable weather conditions and lower population density of our communities. State ownership of land and plant in Russia greatly simplifies the legal and organizational problems involved in developing such systems. But apparent difficulties should not deter us from the enormous possibilities of fuel economy which can be achieved by these projects.

Improvement Achieved

Our largest and most highly developed conventional power plants employing condensing turbines have a heat rate of about 8000 Btu/kwh. In contrast to this an industrial power plant using non-condensing turbines can generate electric power for close to 4000 Btu/kwh. This enormous improvement is achieved by avoiding rejection of heat to the condensers. Wherever there is a large enough heat demand, which can be supplied by exhaust steam from turbines, the possibility of low-heat-rate power generation exists. In such cases the power can be regarded as a by-product of the heating operation.

Thermodynamic Background

At given initial temperature and pressure, we can generate more power in a condensing cycle per pound of steam. To obtain the same power output from back-pressure turbines, we must have a much larger boiler plant, including auxiliaries, than in the case of condensing power generation. Elimination of condensing equipment usually cannot compensate for the additional boiler plant investment costs.

Figure 1 shows that by increasing the initial steam pressure and temperature, power output per pound of steam can be increased. Decreasing the back-pressure has similar effect. However, the back-pressure usually is set inflexibly by the characteristics of the heating load, just as the exhaust pressure of a condensing cycle is determined by the temperature of the cooling water available. Accordingly, we should expect to find in back-pressure operation a trend toward higher initial steam pressures and temperatures similar to that found in condensing cycle operation.

Extreme initial conditions required to achieve the best heat rates in current condensing turbine practice may not be so attractive for back-pressure cycles, since the heat rate in the latter case is substantially independent of steam conditions. Nevertheless, the power engineer seeking to recover the maximum amount of by-product power from a given heating load can be expected to set his initial steam conditions as high as is economically practical.

From a power generation standpoint, the most favorable heat consumers are the ones requiring the lowest back-pressure, which utilize heat at the lowest temperature level. From that point of view, domestic heating service should be the most welcome type of heat consumer.

Figure 2 compares specific power generating capability of steam expanding from 900 psia 1000 F to various back-pressures. The expansion line is drawn most conveniently on Mollier's Enthalpy-Entropy diagram. The table below shows the amount of heat converted to power at different back-pressures.

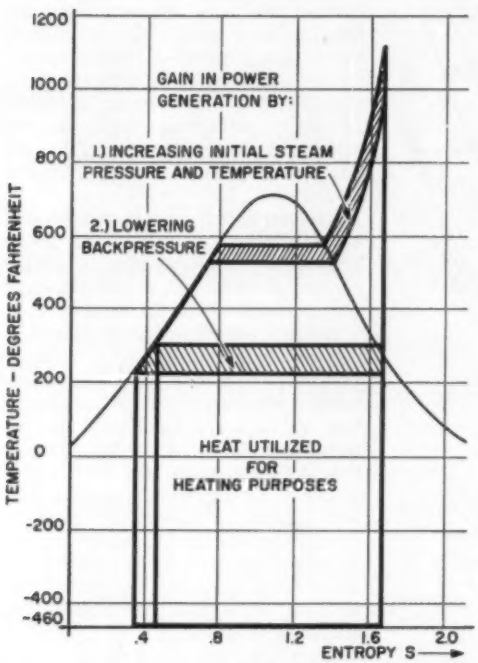
Table points out amount of heat converted to power at different back-pressures

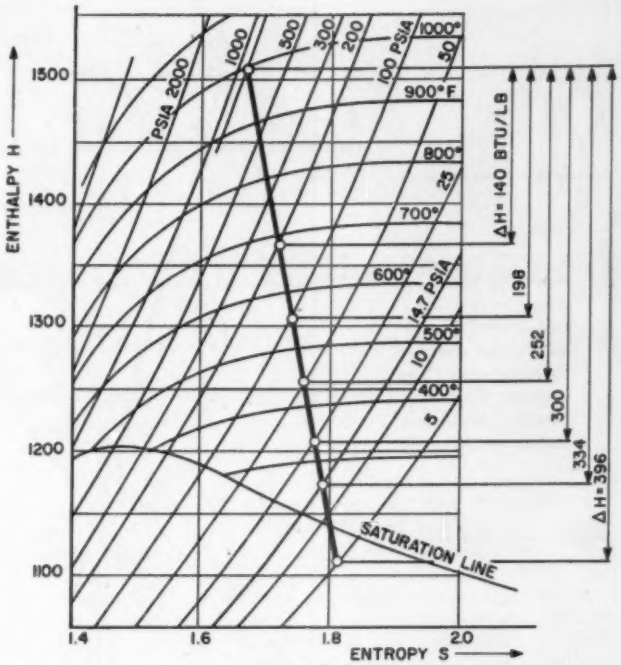
Back-pressure psia	Condensing Temperature F	Enthalpy at Turbine Exhaust Btu/lb	Heat to Power △H Btu/lb	Specific Power Gen. kwh/lb	Specific Steam Rate lb/kwh
200	381.8	1368	140	0.0410	24.38
100	327.8	1310	198	0.0580	17.24
50	281.0	1256	252	0.0738	13.54
25	240.0	1208	300	0.0878	11.38
14.7	212.0	1174	334	0.0979	10.22
5	162.2	1112	396	0.1160	8.62

Highest back-pressure may represent an aluminum processing plant, the lowest one a heating plant. At the selected conditions the heating plant will generate almost three times as much by-product electric power as the aluminum plant, assuming the same amount of steam was used at the same initial condition in both of the plants.

Heat Transport Media

Steam or hot water can be used in the heating system. In practice, the contest between the two systems is over and hot water seems to be the unanimous winner. Modern remote heating systems throughout Europe use hot water almost exclusively





Figs. 1 and 2. Comparison of effect on power generation of higher initial temperature and pressure and lower back-pressure

as their medium of heat transfer.

In the following discussion, we too are discarding the steam heating system, though in some cases, especially when a not too expensive system is involved, and when other industrial requirements are supplied by steam, steam heating can be justifiable and economically superior to the hot water system.

The turbines supplying heating systems can be classified in two main groups:

1. Single-purpose or pure back-pressure turbines.

2. Double-purpose or extraction-condensing turbines.

Single-purpose turbines pass only the amount of steam required for heating. Double-purpose units supply steam through controlled extraction for heating requirements and, having a condenser, are enabled to generate additional power in the condensing cycle.

Both types have their advantages and shortcomings. They should be evaluated by a discussion of some of the typical heating systems.

Pure Back-Pressure System

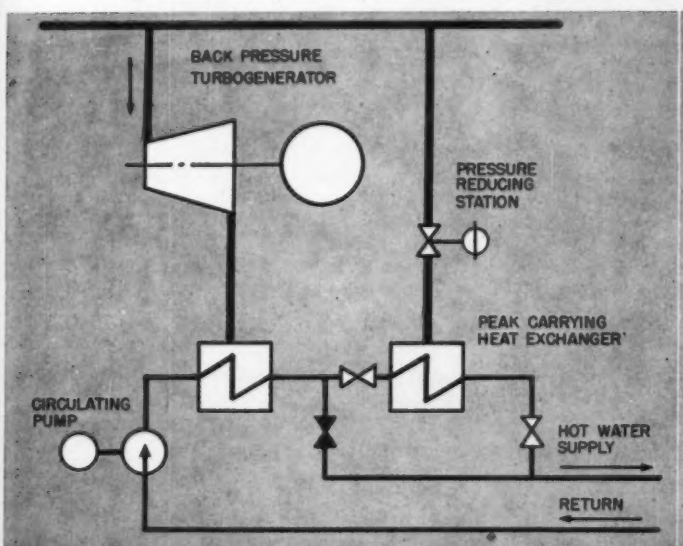
The simplest heating unit is the back-pressure turbine. Figure 3 shows the simplified diagram of such a unit, which is representative of the single-purpose turbine.

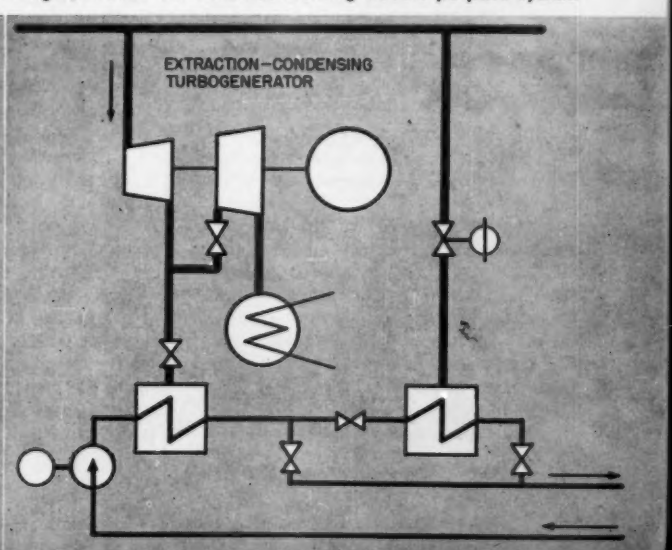
In specifying our heating turbine, we are concerned in determining three main design characteristics of the unit: initial steam condition, design back-pressure, and design steam flow.

Probably the first characteristic is already determined. In most cases we are bound to existing initial steam conditions in a power plant. Determining proper back-pressure and design steam flow takes much more consideration.

It would not be wise to design our turbine for peak heating conditions, since extreme low temperatures occur infrequently. Therefore the turbine is designed for a more frequently

Figs. 3 and 4. Simple back-pressure turbine with peak heat exchanger, and the extraction-condensing double-purpose system





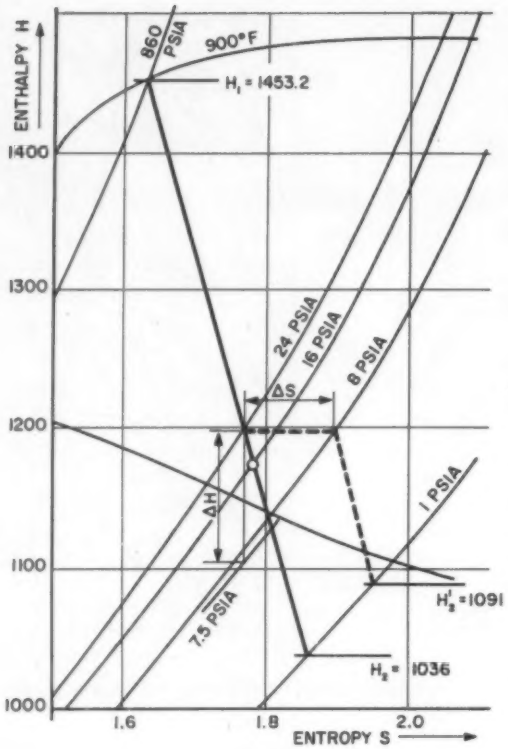


Fig. 5. This Mollier diagram illustrates the analysis of the extraction-condensing system. Text explains conditions shown in diagram

expected low temperature, and an additional peak-load heat exchanger (heated by throttled steam) takes care of the infrequent peaks, as shown in Fig. 3.

Detailed calculations are required to find the best economy. Main points to be considered are:

1. Turbine efficiency drops with decreasing load, although this is counteracted somewhat by the following effect: at lower heating load, lower back-pressure is needed. At lower pressure the specific volume of the steam increases, thus at lower load conditions, despite the decrease in steam flow, the steam volume does not change significantly.

2. Steam throttling means loss in power generation.

3. There is a natural tendency to extend the heating system, by supplying more and more heat consumers. Usually, therefore, the heating turbine is too large at commencement of the service and is outgrown sooner or later by the increasing heat demand.

4. Central control of the supply temperature gives the advantage that, at partial loads, the expansion proceeds to a lower steam pressure in the turbine, increasing the specific power generation (kwh/lb of steam). So the main control operation is performed at the power plant, but a small margin for local individual control must be provided.

This heating unit has the disadvantage that it must be controlled by heat requirements and not by electric power demand. It must run in parallel with condensing units which take care of the varying electric load, while maintaining frequency control.

Extraction-Condensing system

Figure 4 represents a typical extraction-condensing double-purpose system. It has the obvious advantage of being able to operate independently, and it need not be tied to a frequency holding system. If demand for heating steam is reduced, it can shift the load to condensing operation.

Though at first glance it seems to be the ideal heating unit, let us analyze the predictable efficiencies at different load conditions. When compared with a back-pressure unit, one undoubted advantage of the double-purpose unit can be pointed out: the high-pressure section, because of the more uniform flow conditions, works at a higher average yearly efficiency than its back-pressure challenger.

The low-pressure condensing section, however, works under a rather unfavorable condition. Before studying Fig. 5, please bear in mind that in the low-pressure section (*i.e.* beyond the extraction point) the steam passing through is roughly proportional to the pressure *after* the extraction control system.

To evaluate the conditions, let us assume we have an extraction-condensing heating unit with the following design properties: Steam enters at 860 psia 900 F; throttle flow, 250,000 lb/hr; extraction pressure, 16 psia; extraction flow, 125,000 lb/hr; condenser pressure, 2 in. Hg Abs; and condenser flow, 125,000 lb/hr.

The expansion line in the Mollier diagram corresponding to the design conditions is shown in Fig. 5. Under conditions described above, our unit will generate about 25,000 kw.

Assume now that the heating load increases 50 per cent. Condenser flow drops to half of the design value, while the pressure beyond the extraction valve drops to 8 psia. In the meantime the hot water temperature has to be increased, say from 210 F to 250 F, so that the extraction pressure has to be boosted to about 24 psia. The pressure difference between 24 and 8 psia has to be throttled in the extraction valve. That condition is shown on Mollier's diagram in Fig. 5 with dashed lines.

Throttling loss is significant. It can be calculated from the increase of entropy:

$$Q_L = \Delta s . T$$

Where:

Q_L = Loss in availability for isentropic expansion Btu/lb

Δs = increase in entropy (1.892–1.767 = 0.125)

T = absolute hotwell temperature (for 2 in. Hg abs T = 561 R

Q_L = 70.1 Btu/lb

At design conditions, the specific steam rate for condensing part of the steam is 8.18 lb/kwh. For increased heating load, it is 9.42 lb/kwh. We needed 15 per cent more steam to generate 1 kwh in condensation at this changed load condition.

Assume now that heat load drops to half of the design value. If the steam now available should be utilized in condensation, we have to maintain 24 psia pressure beyond the extraction valve to push the increased amount of steam through the condensing part of the turbine. Assume furthermore that water temperature can drop to 170 F, which temperature can be maintained easily by 7.5 psia steam pressure. So we now have to throttle the heating steam. Not taking into account pressure drop through the extraction valve, heating steam has to be throttled from 24 psia to 7.5 psia.

Loss in availability (for isentropic expansion) is:

Δs = 1.900–1.767 = 0.133 T_2 = 630 R

Q_L = 83.8 Btu/lb

Operation of even an extraction-condensing turbine is thus not free

Continued on page 107

CONDENSER AIR-REMOVAL EQUIPMENT

W. E. ELLINGEN OF ALLIS-CHALMERS EXPLAINS

STEAM EJECTORS AND VACUUM PUMPS FOR THIS SERVICE

CONDENSER AIR REMOVAL equipment serves two functions in the steam condensing cycle; first is the initial evacuation of the unit (prior to, or during start-up); second function is to remove air leakage into the condenser during operation.

Since a condenser operates at pressures below atmospheric, there is a tendency for air to enter the condenser continually through leakage. Other gases may reach the condenser as a result of boiler feedwater treatment.

Air and non-condensable gases must be removed from the condenser steam space, as these gases would blanket the condenser tubes and reduce efficiency. It would also produce condensate having a high content of dissolved gases.

Two types of equipment are available for use in removing these gases from a condenser: steam-jets and mechanical-pump equipment.

Earliest condensers used mechanical pumps only. The trend then swung from mechanical pumps to steam-jet type of equipment; and in the past five years there has been an increase in the demand for mechanical pumps.

Steam-Jet Air Pumps

Steam-jet air pumps operate by converting the energy of high-pressure, high-temperature steam into a high-velocity jet. This conversion is accomplished through a steam nozzle. The high-velocity jet entrains and accelerates the air and gases at the suction chamber of the steam jet.

Motive steam, and non-condensables, then pass through a diffuser, which is designed to compress the mixture to a pressure greater than that existing at the suction of the jet. One or more stages may be used.

During the initial evacuation and operation periods, a *hogging jet*, and set of operating jets, respectively, are required. Thus, the hogging jet handles larger quantities of air — at higher absolute pressures — than do the operating jets.

A hogging jet (Fig. 1) compresses air from the vacuum in the condenser to atmospheric pressure, in one stage. In most cases, the motive steam and entrained air are discharged to the atmosphere. It is unusual to design this equipment to discharge at a pressure greater than 1 psig. The hogging jet can be designed to operate with line steam pressure and temperature, or at a reduced pressure. Minimum suggested pressure to a hogging jet is 125 psig.

Consideration should be given to the operating pressure for the hogging jet, since with some turbine units it is necessary to bring the turbine and steam generator up to design pressure and temperature, together. In this instance the design pressure of the jet should be low enough to allow the condenser to be evacuated prior to the time that the boiler reaches a pressure at which steam must be admitted to the turbine.

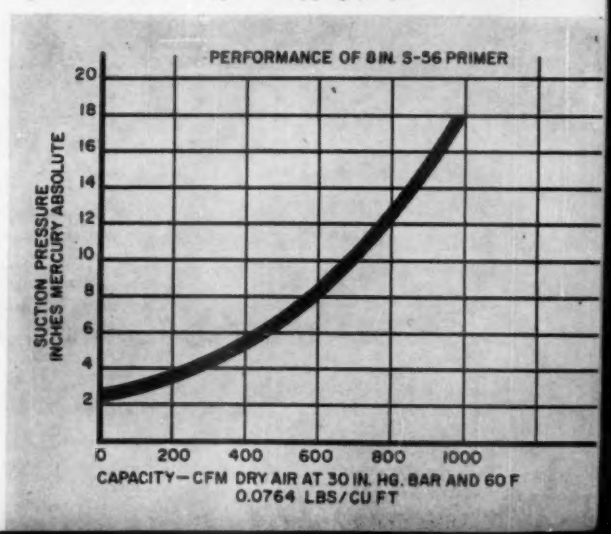
Figure 2 shows a typical hogging-jet performance curve.

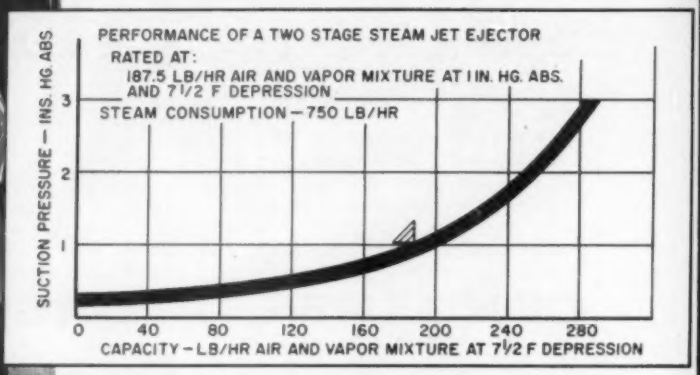
A two-stage steam jet (Fig. 3) is more frequently used to remove the non-condensables from the condenser during operation. This ejector is furnished with intercooler and after-cooler. By compressing in two stages, and by the use of coolers to condense the motive steam, the steam consumption of the multi-stage ejector is maintained at a minimum. Condensate from the main condenser is used as the cooling medium.

This makes possible recovery of the available heat in ejector motive steam. The air ejector drains are usually returned to the main condenser, and this condensate is thus returned to the system. Two-stage

Fig. 1. Non-condensing hogging jet compresses air from the vacuum in the condenser to atmospheric, in one stage

Fig. 2. This shows a typical hogging-jet performance curve





Figs. 3 and 4 show a typical two-stage steam-jet air ejector, with performance curve. More frequently used to remove non-condensables during operation

air ejectors are designed for a given air handling capacity, at 1.0 in. Hg Abs., and saturated with water vapor at 71.5 F. This design condition results in a mixture of 30 per cent air, and 70 per cent water vapor, at the air ejector suction. Figure 4 shows a typical two-stage air ejector performance curve.

Condenser installations having a design pressure less than 1.0 in. Hg Abs. will be furnished with a three-stage air ejector. These are usually designed and rated at 0.5 in. Hg Abs., and have a greater capacity at lower absolute pressures. Figure 5 shows comparative performance of two- and three-stage ejectors for a given steam consumption.

Mechanical Pumps

These can be used for both initial and continual evacuation of the air inleakage to a unit during operation. One type consists of two positive-displacement, motor-driven, sliding-vane vacuum pumps connected in series.

Forged steel rotors and asbestos blades with phenolic impregnation are used. The blade impregnation makes them inert to attack by the water vapors associated with the non-condensables.

Figure 6 is a cutaway of a rotary vacuum pump. An intercooler is installed between the first- and second-stage vacuum pumps, along with a check valve. Intercooler serves to remove the heat of compression from the first stage and condense the water vapor that enters the first-stage pump suction. Check valve allows the second-stage pump to be bypassed until the vacuum in the condenser is approximately 16.5 in. Hg Abs.

Steam-jet equipment has the following advantages: 1. high reliability due to absence of moving parts; 2. very low maintenance; 3. lower initial cost; and 4. operation at practically no cost, if radiation losses through coolers are neglected.

Air ejectors require condensate as a cooling medium, and during periods of low-load, provision must be made to insure adequate flow to the ejector. Provision must also be made for returning drains from the ejector to the main condenser, in order to return this condensate to the system. This requires loop seal piping on the inter-condenser, and a trap on the after-cooler.

Advent of high-pressure and high-temperature units has dictated boiler feedwater treatment which may make it desirable to discard aftercooler drains, to prevent recycling of gases through the condenser.

Desirable Features

Performance of the mechanical pump compares favorably with that of the steam-jet. Figure 7 shows performance of the two types of equipment, operating in the *priming* range, and Fig. 8 shows performance in the *operating* range.

Mechanical pumps have these desirable features: 1. they lend themselves most economically to push-button operation from a remote point; 2. they eliminate the need for auxiliary steam and costly high-pressure steam piping. 3. Since they discharge vapor and gases to the atmosphere, the possible recycling of non-condensables is eliminated. 4. They can be located without restrictions that might be imposed by other types of equipment; and 5. since they are not dependent on steam for operation, they can be operated at any time desired, during the start-up of a unit.

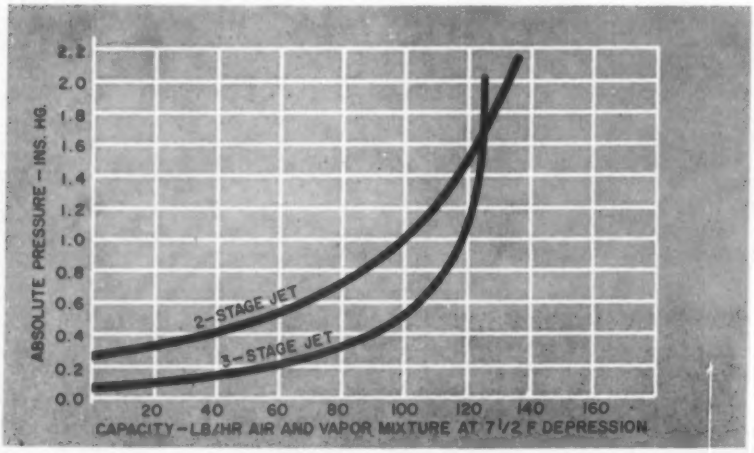


Fig. 5. Comparative performance of two- and three-stage steam-jet air ejectors for given steam consumption

Installations having supercritical steam pressure and temperature, and those installations using the once-through type of steam generators for subcritical steam conditions, *must* use mechanical pumps for air-removal. The once-through type of steam generator does not provide recirculation within the generator. A steam dump arrangement in the condenser is provided to bring this type of unit up to pressure and temperature.

Steam Dump

A steam dump operates during start-up of the unit, and steam is dumped into the condenser, condensed and returned to the boiler. In this fashion the condenser and its associated steam dump act to maintain circulation for the steam generator.

During this starting period, a stable steam supply (required for ejector operation) is not available. The pressure and temperature of the dump steam will vary from low-pressure saturated steam to steam at line conditions.

Turbine manufacturers have established maximum allowable temperatures at the turbine exhaust; in order to stay within the established maximum limits, the condenser must operate under vacuum. Under these circumstances a mechanical pump must be used to maintain the saturation temperature within the condenser at the maximum allowed by the turbine manufacturer.

Spare capacity is required with this type of unit, and the spare should be operated periodically to insure that it is in operating condition. The mechanical type of vacuum pump could be seriously damaged by a slug of water entering its suction; therefore precautions must be taken to prevent this from occurring. Many installations have been provided with a drain tank to avoid such trouble. On shutdown of the vacuum pump, a prescribed procedure must be followed to insure proper drying out of the unit.

For equivalent capacity, mechanical pumps will cost approximately twice as much as the steam-jet type of equipment. This comparison is made on the basis of furnishing two single-element, two-stage, steam-jet ejectors with a primer, as opposed to furnishing two mechanical vacuum pumps.

These two types of equipment are available to remove air and noncondensables from a steam surface condenser. Due to the advantages and limitations of each type, careful consideration must be given to the choice of equipment to be used in any particular installation. THE END

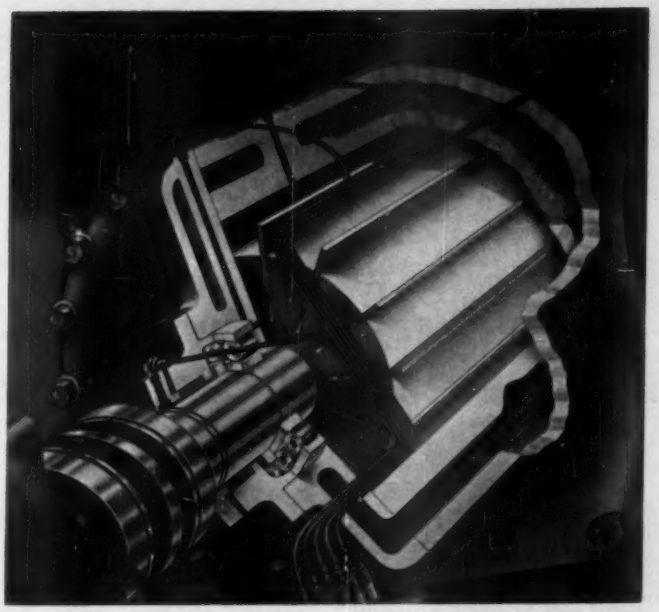


Fig. 6. Cutaway of rotary vacuum pump used for air removal service

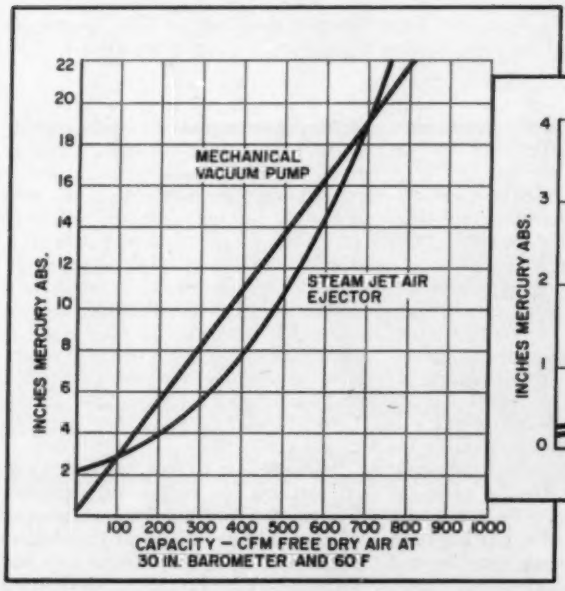


Fig. 7. Comparative performance curves for priming range

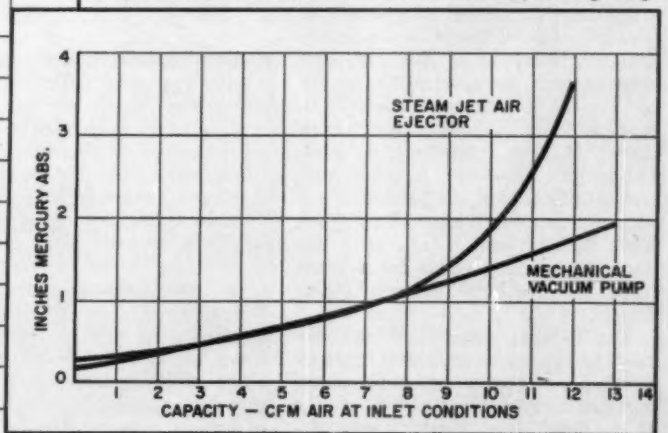


Fig. 8. Comparative performance curves for operating range

PAN-AMERICAN ENGINEERS MAP HEMISPHERE TRAINING NEEDS

DICK MORRIS REPORTS FROM BUENOS AIRES ON THE FIRST PAN-AMERICAN CONGRESS ON ENGINEERING EDUCATION

MEANS and methods of improving engineering education, adapting it to the needs of individual countries and coördinating teaching methods among all engineering schools in the Western Hemisphere were outlined at the First Pan-American Congress on Engineering Education. The Congress was held in the Engineering College of the University of Buenos Aires, September 12 to 18, and was attended by over 200 delegates from 16 Pan-American countries.

How Meeting Came About

The meeting was an outgrowth of many years' endeavor by the Engineering Education Committee of UPADI, the Pan-American Union of Engineering Societies. In the United States the UPADI member is the Engineers Joint Council, of which the AIPE is an associate member and a long-time financial supporter of UPADI. The Committee on International Relations of EJC, in joint meeting with the Committee on International Relations of the ASEE, coöperated on the U. S. program with Ralph Morgen, president of Rose Polytechnic Institute, as Chairman and coördinator of the project. Final participation was a joint effort of the EJC, ECPD and ASEE, with the financing made possible by a grant from the National Science Foundation.

The general theme and arrangement of the Congress is well outlined in the list of papers (see box), covering the formal contribution of the U. S. delegation. Working committees were set up following this outline. Each committee considered in detail similar contributions by delegates from all the countries and proposed a series of recommendations which was later submitted to the entire assembly.

Fig. 1. The first session on September 12 was held against a colorful background of the flags of the Americas. Dr. Ralph Morgen, president of Rose Polytechnic Institute and leader of the United States delegation, is shown at the extreme right

Long range objectives and responsibilities of engineering schools throughout the hemisphere were cataloged thoroughly and with reasonable agreement among delegates with widely differing present-day standards. Thus the conference, which was to a large extent an inventory of present methods and standards, established a plane of reference upon which future conferences can build to bring about gradually increasing standards of professional education adapted to the needs of individual countries.

Aside from the active participation of various government agencies and the Organization of American States in the Congress was the wide acceptance of the principle of close coöperation and coördination with similar movements between the U. S. and Western Europe; namely, EUSEC and IAESTE. The former organization is concerned with engineering education and education standards and the latter with the exchange of upperclass engineering students between countries. Both of these topics were set aside for more detailed discussion and consideration at the UPADI meeting to be held the following week.

More than a score of resolutions or suggestions for action were passed. The most important immediate need of many countries is a full-time teaching staff. The importance of this was summarized by Prof. J. L. Meriam as:

"The success of a program in engineering education depends in the long run on the quality of its teaching rather than on the character of its supporting administrative framework and curricular structure."

A problem in all countries is the quality of secondary schools and the adequate preparation of entering college students. There is an immediate need for an inventory and evaluation of secondary schools and for methods of screening and selecting engineering students. Some countries place considerable reliance on aptitude and achievement tests, but these are questioned in many quarters. The U. S. opinion as expressed by Dr. Morgen is:

". . . there are many who believe the excellence of the graduates of the Bachelor's level . . . bears a stronger relationship to the screening of students at entrance than to a variation in the presentation of subject matter . . . at colleges."

As in all international conferences, the matter of vocabulary is of major importance. In the educational field, good work on vocabulary standardization has been completed by EUSEC, a well-integrated program of educational coöperation between Western Europe and the U. S. Introduction of EUSEC activities into the Buenos Aires Conference will do much to promote future communication and understanding among the countries involved.

The University of Buenos Aires has been carrying on library activities and an abstracting service on educational literature, and they volunteered to carry on this activity for the Congress pending the establishment of a permanent headquarters, secretariat and international center for disseminating information and for coöperation with other international agencies such as UNESCO and the OAS.

Exchange of students and instructors among countries was universally approved, and the IAESTE program was endorsed.

Graduate Programs

B. R. Teare, speaking on graduate programs, emphasized: "Graduate study is desirable as preparation for research, development and design, especially for the newer advanced areas where the problems are growing progressively more complex; and for faculty posts in the engineering colleges." Industrial needs of many countries at the moment, however, are not of such a complex nature, and one of the basic needs of many would seem to be a well-coördinated system of vocational schools to supplement institutions of higher learning and meet the crafts and technician needs of the economy.

At the present time, civil and sanitary engineering tend to dominate Latin American circles, and there have been several recent conferences of the same general nature sponsored by the National Science Foundation and Cooper Union. Robert Stiemke reported on these conferences which to a large extent paralleled the Buenos Aires Congress but in more specific areas.

While UPADI activities in general skirt political problems, the question of legislation or licensing engineers is one which can hardly be sidestepped in any meeting of engineers. Practices and difficulties in the U. S. were thoroughly reviewed for the Congress by J. H. Sams. In part he said: "Various state boards are making every effort to develop more uniform practices, . . . are . . . from time to time amending their laws . . . for more uniform requirements . . . so that an engineer desiring to practice in more than one state will not have too much difficulty . . . in additional states after he has registered in one. . . ."

Students play a much more important part in the control and operation of universities in the Latin-American countries than they do in the United States. A student from the University of Rio de Janeiro, representing the student council, made a plea that at least one student member from each UPADI country be invited to the next and subsequent congresses. This met with unanimous approval and will be incorporated in future programs, supposedly on the basis that the national delegations from each country will finance the venture.

While this report is confined largely to the U. S. participation in the Congress, the importance of the Congress on Engineering Education in the future should not be underestimated. It is proposed to publish all papers presented in English, Spanish and Portuguese in UPADI publications. At the moment, however, funds for this purpose are uncertain. In the meantime, copies of all papers, in their original language, will be on file at the headquarters of the Engineers Joint Council, 29 West Thirty-ninth Street, New York City. The U. S. papers will be published in the Journal of the American Society for Engineering Education, University of Illinois, Urbana, Ill. Prof. W. Leighton Collins is Secretary. THE END

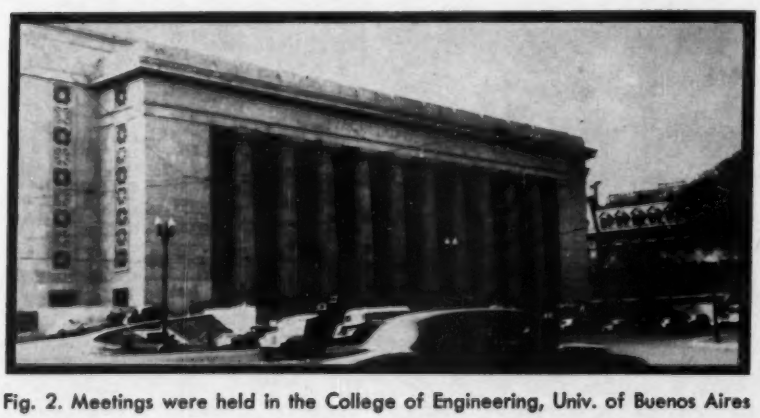


Fig. 2. Meetings were held in the College of Engineering, Univ. of Buenos Aires

Papers Presented by U. S. Delegation

1. *Admissions Requirements to Institutions of Higher Learning* by Ralph A. Morgen, President, and Gustave C. Zader, Director of Admissions, Rose Polytechnic Institute, Terre Haute, Indiana.
2. *The Engineering Curriculum* by Dean Frederick C. Lindvall, California Institute of Technology, Pasadena, California.
3. *The Engineering Faculty* by Dean W. L. Everitt, College of Engineering, and president ECPD, University of Illinois, Urbana, Illinois.
4. *Registration of Professional Engineers* by J. H. Sams, formerly Dean, School of Engineering, Clemson College, Clemson, South Carolina, and now Executive Secretary, National Council of State Boards of Engineering Examiners, Clemson, S. C.
5. *The Graduate and Research Programs in Engineering* by Dean B. R. Teare, College of Engineering, Carnegie Institute of Technology, Pittsburgh, Pennsylvania, and Past President ASEE.
6. *Exchange of Professors and Students in Engineering* by Dean H. K. Justice, College of Engineering, University of Cincinnati, Cincinnati 21, Ohio, and Mr. Josef Wischeidt, Jr., Executive Secretary of the United States Committee of the International Association for the Exchange of Students for Technical Experience (IAESTE).
7. *Effective Engineering Teaching Through Realism With Examples from Applied Mechanics* by Professor J. L. Meriam, University of California, Berkeley, California.
8. *Report on Current Thinking Concerning Civil Engineering Education* by Dean Robert E. Stiemke, Georgia Institute of Technology, Atlanta, Georgia.

DOES YOUR BOILER NEED A DOCTOR?

FRED SPITZ OF CHEMICAL TESTING CORPORATION, N. Y., TELLS WHY YOU NEED THE ADVICE OF A SPECIALIST FOR EFFECTIVE BOILER WATER TREATMENT

MAN HAS BEEN COMPARED with a machine. Similarly, a steam generator may be compared with man: its parts compared with human counterparts and its ills equated with human diseases.

Water flowing through the tubes is the bloodstream, and scale formation becomes a distinct case of hardening of the arteries. The heart of the boiler is the feedwater pump. Its regulators and controls, designed to warn of impending danger, are the nervous system of the boiler.

Corrosion is the cancer of the boiler. You never know where or when it will strike, and if you don't catch it soon enough, it can be fatal.

Steam generators need a vacation and a physical check-up regularly. Fortunately it is much easier to examine a boiler internally than a person . . . and to a large degree it is also easier to prescribe the necessary treatment to cure its ailments. But there is no wonder pill . . . no automatic cure-all. It is absolutely necessary to make periodic check-ups to assure that the treatment is having its desired effect, or if adjustment in the prescription is necessary.

Perfection Is Impossible

If the material, design, construction, operation and inspection of a boiler were ideal, it should be safe to operate indefinitely. In other words, a piece of steel plate should carry a static load of approximately ¼ of its ultimate strength indefinitely . . . if it could be protected from excessive temperature changes, moisture and corrosion. However, one or more factors affecting the problem can be expected to fall short of perfection so that sooner or later boiler repairs become necessary.

No boiler disease is more prevalent and more difficult to control than corrosion. As with human cancer, if you catch it early, it is curable. However, internal corrosion is not so easily detected and it can develop rapidly into a disaster.

Corrosion Difficulties

Corrosion in water and steam lines of steam generators is generally attributed to the presence of oxygen. Use of chemical treatment and deaerating equipment has alleviated many of the former corrosion troubles, particularly in piping. In condensers, condensate piping, boilers and turbines, however, the problem is still aggravating and dangerous.

Many engineers have experienced corrosion difficulties coincident with the elimination of scale, which led in some instances to the practice of actually treating the return condensate to a dose of scale-forming ingredients on its way to the boiler. Today this practice does not meet with general favor, as it is believed the elimination of oxygen is the correct solution. Nevertheless corrosion does occur in boilers where extreme care is taken to eliminate oxygen.

The location of the affected parts varies with boiler design, feedwater discharge, rate of evaporation, blowdown practice and anything else likely to change evaporating conditions within the boiler. Identical boilers in a battery show symptoms of corrosion on entirely different parts of the interior.

Another vulnerable point of attack is the steam turbine blades. Combined with the erosive action of condensate, oxidation of the blades presents a problem that is extremely baffling, and a satisfactory solution is still being sought. Even the condenser, which functions in many instances as a deaerator, is subject to the processes of a corrosion attack.

Fig. 1. Changeover to proper treatment loosened and removed old scale and prevented formation of any new scale

Like cancer, oxygen corrosion is prevalent among the aged. Feedwater on the acid side may corrode the steel to a dangerous degree, but free oxygen and other gases are responsible for most of the intense corrosive action ordinarily termed "pitting." Engineers will do well to make frequent and careful inspections of equipment subject to corrosion and use treatment to keep the oxygen content of the feedwater down to the minimum possible.

Feedwater Vitally Important

Feedwater, either directly or indirectly, has a greater influence on safe operating conditions of a boiler than all other factors entering into boiler operation. Sediment in the form of scale forming upon the heating surfaces retards the flow of heat through the boilerplates and tubes to the water. Those parts then reach a high temperature so that bulging and thinning of metal occurs, even to the extent of rupture, with resultant leak-

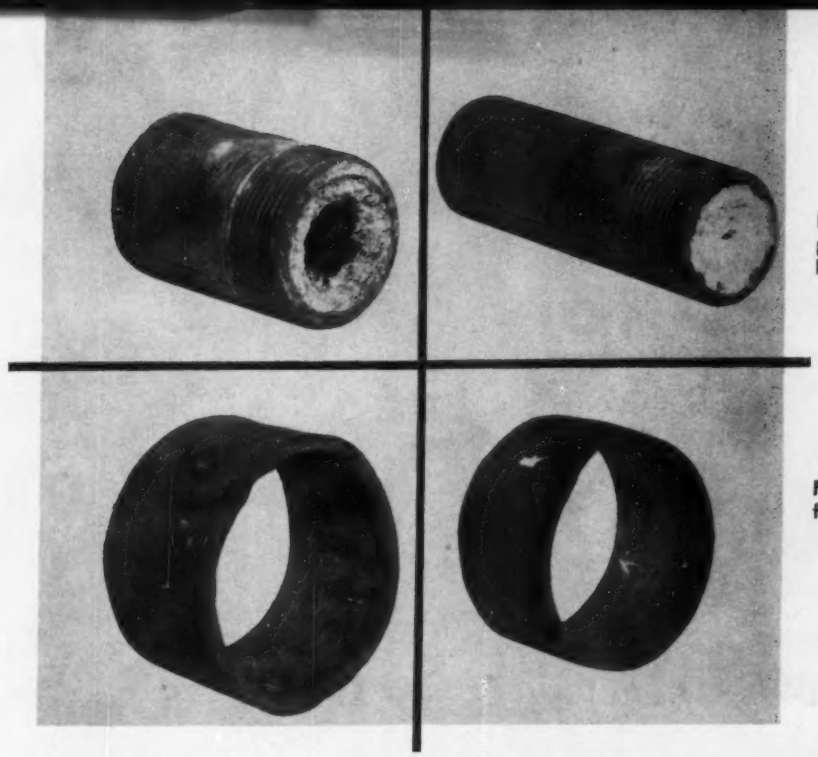


Fig. 2. One half- and one almost completely-plugged tube. This could have been prevented with proper treatment

Fig. 3. Deep pits and complete perforations in tubes caused by corrosion

age. Overheating due to scale and oil is responsible also for much of the leakage which develops at seams and and tube ends.

Lubricating oil of any description and in any quantity is objectionable in a boiler, and oils containing animal fat are certain to cause overheating. Under boiler pressure and temperature, oil does not float on the surface of the water, but is carried by the circulation to all parts where it forms a film on the heating surfaces. Oil is a poor conductor of heat and prevents the wetting of the metal so that the high rate of heat absorption necessary to keep the plate relatively cool is lacking.

Oil + Scale = Trouble

Steel plate is weakened at high temperatures, and, when overheated, bulging of a large area of the shell plate is likely to occur. When oil is combined with scale or other sediment, overheating and bulging can be quite rapid, and although the bulge might be comparatively small, it might also be so deep that a rupture will occur at the thinnest point.

Boiler water *must* be treated. Science has advanced the theory of water treatment from the early days of putting potatoes in the water to the point where each chemical used serves a particular purpose. Phosphates react with calcium, magnesium and other mineral salts that form scale; soda ash or caustic soda maintains an alkali condition in the boiler; sodium sulphite eliminates the presence of oxygen; amines control return line corrosion; and colloids maintain the sludge in a non-adhering condition.

Colloids are a study by themselves, each having certain qualities to suit a different condition. New materials are being investigated all the time, and we hope that some day the mystery of water conditioning will be solved.

Knowledge of these chemicals is worthless unless you know the conditions under which they are to be used, type and quantity of raw make-up water, quality and amount of returns, working pressures and temperatures. All these factors for each individual case must be considered before the correct combination of chemicals can be prescribed. It is not enough to do it just once. Changing conditions of both the operating and physical make-up of the water necessitate periodic analysis of the boiler water to give proper control on feeding and blowdown.

Laying-up Procedures

Approach of summer calls for the laying up of heating boilers, and also, in many cases, change over to a spare power boiler. Many an engineer believes that when a boiler is idle it needs no care or treatment — *that is not so!* At this time conditions are most favorable for corrosion and pitting to occur at the water line. This corrosion is not controlled by alkalinity. The caustic in the water may be dissipated by the inleakage of feedwater or by carbon dioxide present in the air, leading to acid corrosion. Condensed moisture forming droplets above the water line are the basis of pitting and erosion, since these drops contain oxygen and have no alkalinity.

Wet Method or Dry?

There are two generally accepted methods for laying up a boiler: the wet method and the dry method. Each method has its pros and cons. Generally speaking, when the boiler is idle for a month or so, the wet method is considered more favorable, because the boiler can be placed back on the line that much quicker. For longer periods, three months or more, the dry method is more suitable because it does not need as much care and control. For a certainty the dry method is used when an entire plant is layed up and freezing weather may be anticipated.

Patent medicines by the hundreds are on the market. There is even the old fable that blowdown is a cure-all for all boiler plagues. The remedy lies not in blowdown alone, nor in untested proprietary boiler compounds, but in a formula prescribed to suit your operating condition and the character of the water used.

Proper way to treat your boiler water internally is with the necessary chemicals for the particular conditions that prevail in your plant; to use a compound that is backed by up-to-date engineering and scientific principles; to have periodic analyses made of the boiler water and raw water which often change in character during the year; and to rely upon the advice of only reliable, experienced specialists in boiler water treatment. THE END

Fig. 1. Thos. H. Allen plant (left) with its unloading tower (far right), transfer house next, then coal crusher

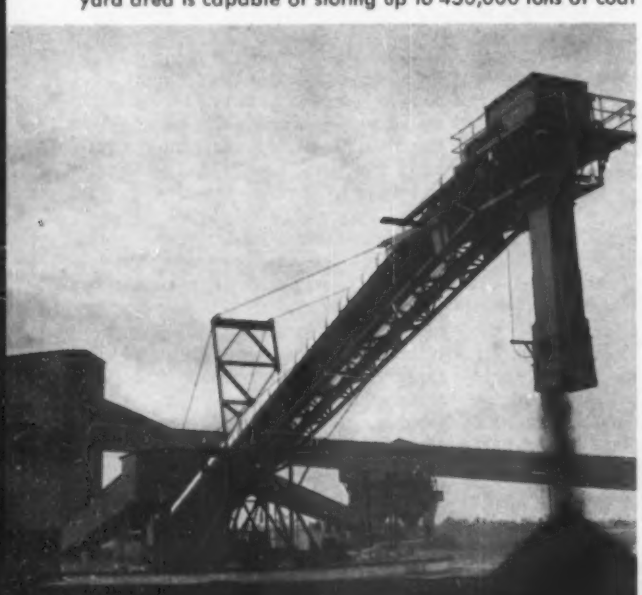
COAL TO MAKE 750,000 KW

THIS IS HOW IT'S UNLOADED AND HANDLED AT THE NEW THOS. H. ALLEN STATION, AS OLD BY D. H. KREGG, WHO WAS PROJECT MANAGER ON THE JOB FOR BURNS & ROE

COAL-HANDLING requirements and facilities at the Thos. H. Allen Electric Generating Station, Memphis, Tenn., were determined by the consulting engineers, Burns and Roe, Inc, of New York City. This new power plant, serving the needs of Memphis and surrounding Shelby County, consists of three 250,000-kw (nameplate) units. It is the only generating station of the Memphis Light, Gas and Water Division, and its coal-handling system is one of the largest.

Barge transportation was found to be the cheapest means of carrying coal to the station. Rail unloading facilities were considered as back-up, but the capital cost was prohibitive, particularly because favorable rail transportation rates would not be guaranteed if barge facilities were installed. Also, inasmuch as a 90-day coal supply is maintained at the plant, alternate means of delivery were deemed unnecessary.

Fig. 2. This stacking-out-conveyor can deposit up to 7500 tons of coal in the storage area without secondary handling. Plant yard area is capable of storing up to 450,000 tons of coal



The plant site has approximately 3000 ft of waterfront property, which had to be dredged to permit unloading of coal. (Incidentally, dredged material was used to fill the plant site, which was below maximum river flood stage.)

Discussions which were held with barge operators determined required dimensions of the harbor area, and the size and number of barges in a tow.

Because the Mississippi River rises or falls about 57 ft at Memphis, it was not possible to design the coal-handling system for just one unloading tower. Instead, two unloaders were installed in a unique arrangement known as a Siamese Tower. (See Fig. 3.) Separating the towers for independent operation would have meant additional live and dead storage of barges, therefore more waterfrontage. Cost for the coal-conveying system and the increased mooring facilities and harbor space would have been considerably higher.

System Criteria

Unloading towers were sized to handle ultimate plant capacity. The twin booms have a reach to unload two 1500-ton barges side by side, each boom extending about 80 ft beyond the dock face. Each tower has a free digging capacity of 1300 tons per hour. To assure continuous loading of the conveyor belts, the unloader is equipped with 900-ton hoppers.

Washed coal with a maximum size of 2 in. is normally available. However, knowing that lump sizes up to 6 in.

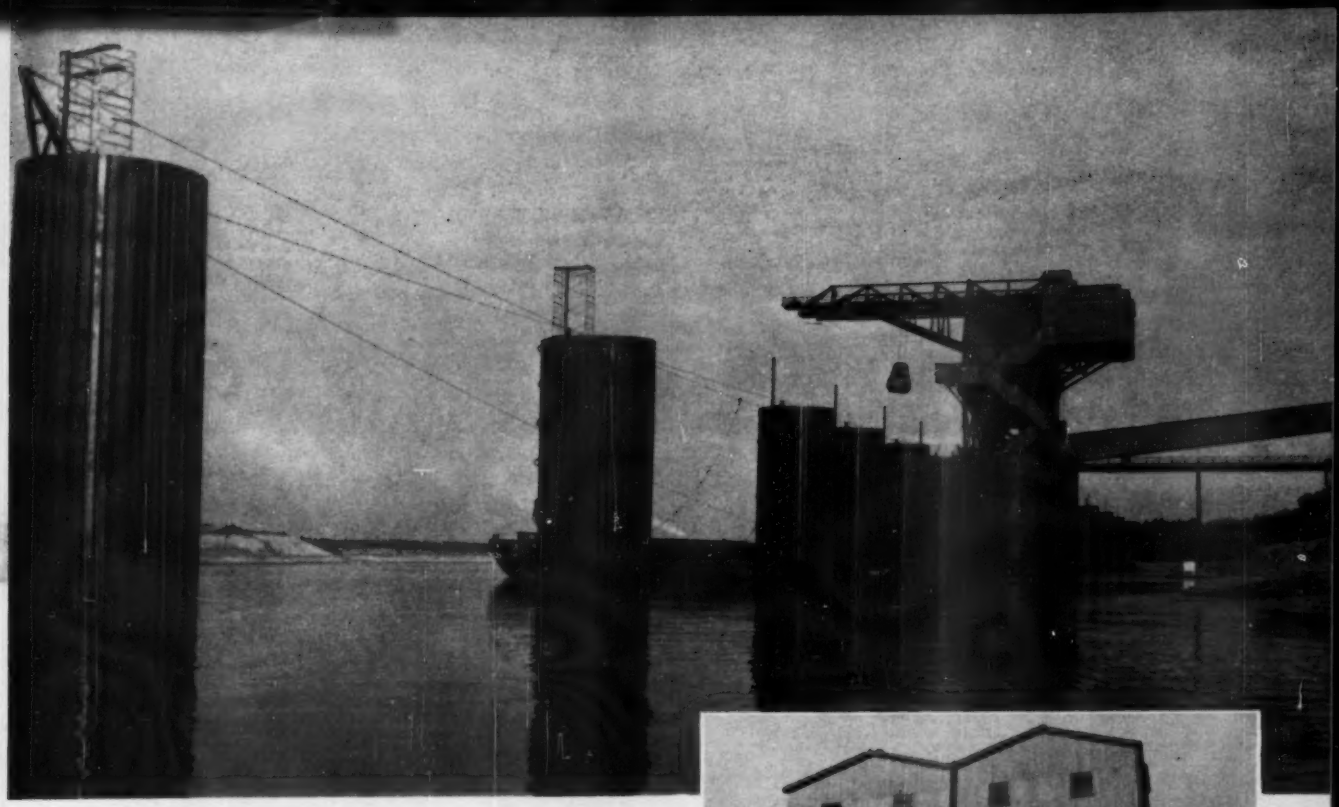


Fig. 3. Mooring facilities at the Thos. H. Allen Station. Twin unloading tower is at right and in photo at right. Each tower has a free digging capacity of 1300 tons per hour

have to be handled occasionally, Burns and Roe designed the coal-handling system to meet the demands of the following criteria:

Reliability. Although present plant capacity could have been handled with one belt, this was not considered advisable for a 750,000-kw station. Dual belts were installed.

Ease of stacking out. Large tonnages have to be handled even when mobile coal-moving equipment may be out of service. Also, to unload a string of barges without moving stockpiled coal, a traveling stacking-out conveyor was provided, having 60-deg horizontal travel and the ability to deposit 7500 tons of coal without further handling. Because stacking is not as critical as the plant supply, only one conveyor belt was provided for this purpose.

Reclaiming. Up to 450,000 tons of coal may be stored, all of which may at some time have to be reclaimed from the pile. Therefore, two reclaiming hoppers were provided to minimize interference of mobile equipment and to shorten the distance it has to travel.

Crushing capacity. Two crushers out of an ultimate four have been installed in the present system. These crushers, with a total capacity of 1200 tons per hr, were the largest of their kind at the time of purchase and are capable of crushing coal from 6 in. to minus ¼ in. Each of two conveyors to the crusher house can supply either crusher; crushers, in turn, can feed either of two belts leading to both sides of the boilers in the plant.

Bunker filling. Because each boiler is fired by opposed cyclones on front and rear furnace walls, coal bunkers were installed on two sides. Each string of bunkers is fed by a conveyor belt with a traveling tripper, the latter equipped with a by-pass gate. When the tripper is bypassed, coal continues to the head end of the belt, where it discharges into the end bunker. Thus, it is not necessary to empty the belts in order to move the traveling tripper from one bunker to another.

As future units are added to the station, only new bunker conveyors (with trippers) and additional crushing capacity will be needed to handle the increase in fuel consumption.

Control. At the top of the transfer tower, a control room for the entire coal-handling operation permits the operator to observe unloading, stacking, and reclaiming. A control board, equipped with a mimic bus and lights, shows operating parts of the system. Also, another serviceable feature, bunker indicating lights, tells operators the coal level at all times.

Structures. All structures of the coal-handling system are enclosed with colored Steel-bestos, to harmonize with the main plant's architectural treatment. Galleries have concrete plank floors.

Coal-conveying equipment and necessary structures were furnished and installed by the Link-Belt Co. Coal-unloading towers were furnished and installed by the Dravo Corp. THE END

STATIC RELAYS HERE AND ABROAD

COLIN ADAMSON, MANCHESTER (ENGLAND) COLLEGE OF SCIENCE AND TECHNOLOGY, COMPARES BRITISH AND AMERICAN PRACTICE

AS NOTED in his article in the August, 1960 issue of POWER ENGINEERING, p. 98, this writer spent two instructive months in the fall of 1959 in the U. S. A. and Canada, and learned something of the attitudes of the various power utility companies and the manufacturers toward modern static relaying.

Claims have been made on numerous occasions on both sides of the Atlantic to awards of priority in introducing static relaying. There is some substance to many of these claims, but most of them are based on the transductor (magnetic amplifier), which is not in great favor nowadays in protective gear applications, or on conventional electronics, which was unacceptable to protective gear engineers for the reasons advanced in the August article.

Time/Overcurrent Relays

Induction-type overcurrent relays are in use on the world's power systems in quantities greatly in excess of all other forms of protection. This is only a reflection of the basic fact that most protective gear application problems are time-grading problems on low and medium voltage systems. Result is an extremely competitive situation in that the market, being large, provides very favorable conditions for quantity production.

Although it can be demonstrated that an overcurrent relay of very versatile performance can be built with transistors and certain other components, including a slave relay, it cannot on grounds of cost displace the present relays for ordinary applications at present. This statement is made notwithstanding the fact that a prominent Midwest electrical manufacturing concern has recently advanced a static overcurrent relay with readily adjustable characteristics, and a British manufacturer interested in the American market has had transistorized overcurrent relays with special characteristics installed on the extensive traction network of the London Passenger Transport Board.

Furthermore, the curve which is considered generally desirable for these relays in normal applications is defined in the United Kingdom by British Standard 142, and by a similar characteristic in Europe and the U. S. A., and is awkward to reproduce in a static relay. This characteristic in normal relays is controlled at high current values by magnetic saturation, and gives the "definite minimum time" feature. There is evidence that this curious characteristic is not regarded as highly in the U. S. A. and Canada as in Britain.

If, as a first stage, some static overcurrent relays are to be manufactured and applied to time-graded protection, it is clearly important that a proportion of them should coördinate with other relays of traditional pattern. Static time/overcurrent relays, whether of a transistor variety or not, invariably consist of a time-delay network associated with a level detector which may, or may not, have directional properties. The time delay network is thus the element of the relay which must simulate the normal B.S. 142 curve.

Reactive/resistive impedance combinations are the only simple means available for producing the desired time-delays. Although non-linear elements (e.g., saturable inductance) may be used to give the characteristic arising from the motion of a disc in a saturable magnet system, the difficulties are very apparent. There is the possibility also, although it seems

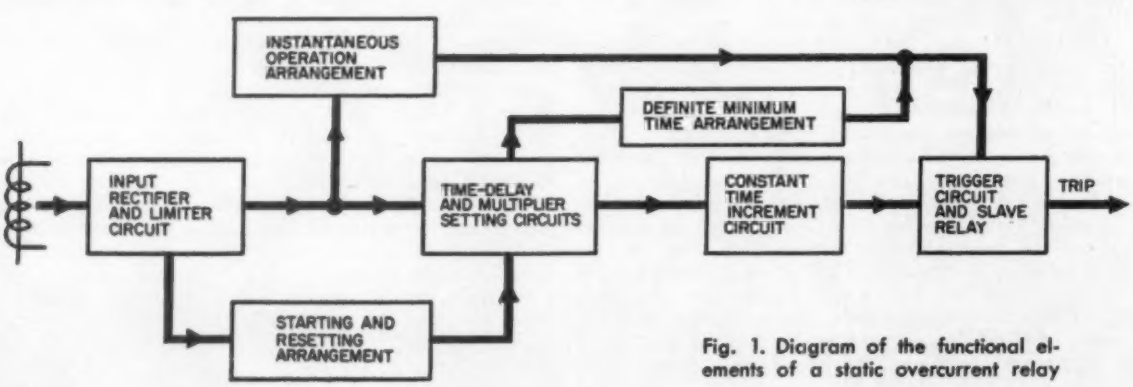


Fig. 1. Diagram of the functional elements of a static overcurrent relay

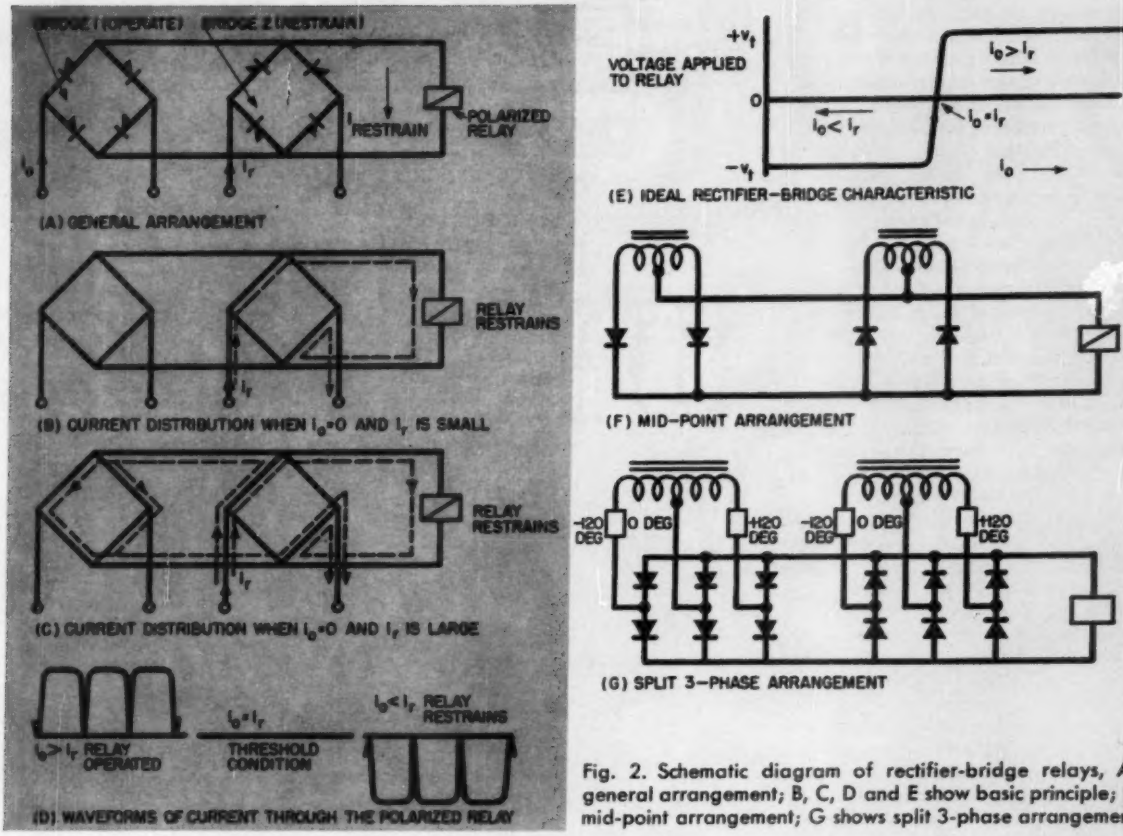


Fig. 2. Schematic diagram of rectifier-bridge relays, A-general arrangement; B, C, D and E show basic principle; F, mid-point arrangement; G shows split 3-phase arrangement

invariably to give rise to high cost, of producing a characteristic by means of biased diodes.

On both sides of the Atlantic, however, relays are manufactured which have current/time characteristics alternative to the B.S. 142 type of characteristic. These are at present loosely known as "very inverse" and "extremely inverse" relays and follow approximately the laws $K = I\,t$ and $K = I^2 t$, respectively. Other applications of relays occur in associated fields of electrical engineering where relay characteristics for matching purposes of the form $K = I^n \cdot t$ ($n > 2$) are necessary. In these fields the static overcurrent/time relay has found its first applications; that is, in those fields in which the conventional patterns of overcurrent relay cannot compete in electrical performance.

Figure 1 shows in block form the variety of functions necessary to make up an overcurrent relay with versatile characteristics. Starting and resetting arrangements employ the same components, for they both involve short-circuiting of a timing capacitor, the former to insure that there is no voltage across the capacitor before receipt of the fault signal. The instantaneous-operation and definite-minimum-time features have the same functions to perform as in a normal relay, but the constant-time-increment circuit is additional. Practical developments to provide the functions of Fig. 1 were contributed by J. L. Dineley in collaboration with the author, and have not been published.

Such relays are not simple and as a minimum require five transistors, a diode, and several resistors and capacitors apart from the input arrangements. The input arrangements must provide not only the input signal, but also the voltage for the collector-emitter circuits of the transistors. This can be derived from the secondary of the current transformer through rectifier-limiter arrangements and can vary considerably without affecting the correct operation of these relays. Recent work has greatly improved the temperature performance, which, in the early relays was poor, and their cost has been reduced.

Rectifier-Bridge Comparators

From British and European points of view, the effective static competitors to transistor comparators of various types are the rectifier-bridge comparators. Relays based on them are undoubtedly producing a great deal of excitement among protection engineers in Europe. If the advantages are required that have been claimed over the years for electronic relays, then the relays based on rectifier-bridge comparators are clearly most effective competitors to any relays based on transistors, and may possess more desirable features. Whether or not this situation will continue is a matter for the future.

Arrangement of components illustrated in Fig. 2A was originally applied to relaying by Norwegian and German engineers. It now attracts widespread interest and is in use commercially in the U.K. and elsewhere. Considerable divergence of opinion exists with regard to the best types of rectifier to be used for these applications, the four main possibilities being selenium, silicon, germanium and copper oxide.

Selenium has had the widest application in the U.K. and is preferred on account of its well-defined threshold on the current-voltage characteristic, a tendency to retain its initial characteristics with aging, and a good overload performance. Silicon is in use, however, in North America, and it is claimed that such rectifiers are very satisfactory in relaying applications. Some German opinion favors

germanium, largely on the grounds that such rectifiers are much less susceptible to failure because of moisture than selenium or copper oxide types.

It has also been suggested that selenium rectifiers deteriorate in fluorescent lighting whereas germanium and copper oxide do not. Opinion in favor of copper oxide appears, at the time of writing, to be mainly confined to Germany and is apparently the result of recent developments.

As with all electronic and transistor relays, the properties of this class of relay are no longer inherent to the moving element and are determined by the static circuit elements external to it, in this case the non-linear rectifier elements; the slave relay is polarized. The basic principles may be appreciated by reference to Fig. 2.

A value for v of the order of 0.25v is a typical setting for the polarized relay. When both bridges are energized simultaneously, the complete relay arrangement is acutely sensitive to small differences between I_e and I_r without a delicate setting for the slave relay or a high thermal rating for its coil. The composite characteristic for the relay is shown in Fig. 2C and indicates the very rapid turnover in the characteristic obtainable at the threshold. Actual input quantities of the bridge obviously depend on the application. The arrangement is suited to any comparison which has to be made between two relaying quantities, however derived, and an application will be considered later in relation to the use of transistors.

Further possible arrangements are shown in Figs. 2F and 2G, the "midpoint" and "split three-phase" connections, respectively. The former is roughly equivalent to the rectifier bridge of Fig. 2A; and Fig. 2G, by artificially increasing the phase number, may be used to give less ripple in the d-c output.

Relays based on these elements have been found, in British practice, to be suited to transformer, pilot-wire and accurate distance protection.

Distance Protection

Work on transistor distance relays was carried on coincidentally in the U. S. A. and in the U.K. during 1954–55 by Bergseth, and Adamson and Wedepohl. Bergseth applied the principles used in his electronic distance relay to his transistor relay, and his work has resulted in a long-term field experiment on the Bonneville system. The British work was concerned, at first, more with high-speed transients arising from high values of source impedance and source X/R ratio. The great deal of subsequent work has always relied on high-speed test bench facilities of the type described by Hamilton and Ellis. This writer's view, borne out by the last few years' experiments and experience, is that transistor distance protection cannot be made economic with respect to relays based on rectifier bridges at the present time.

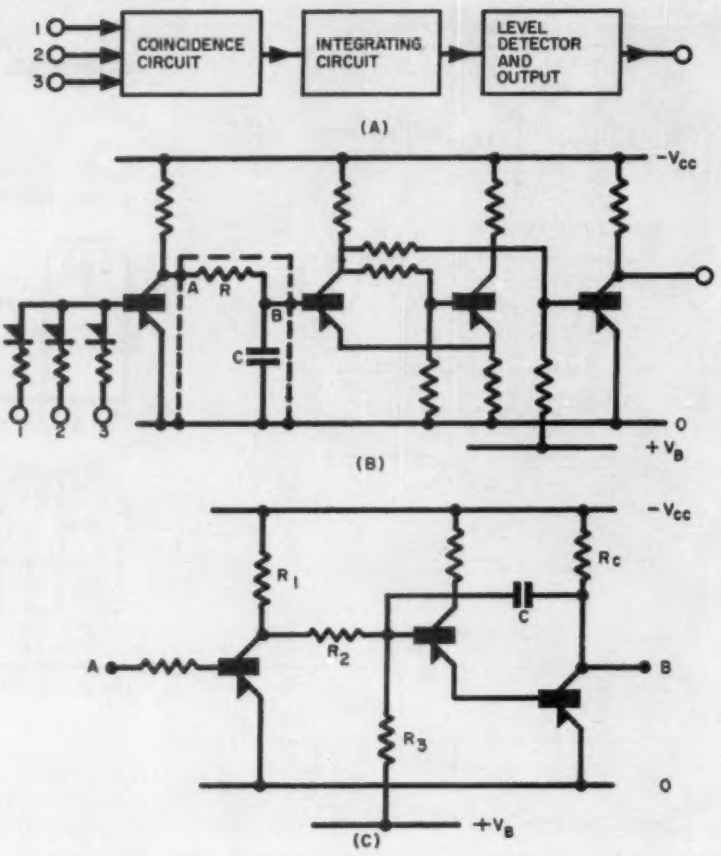


Fig. 3. Diagrams of a phase-comparator circuit. A—block schematic diagram; B—arrangement for detecting coincidence; C—the linear integrating circuit

Carrier Protection

Carrier protection is an obvious choice for the application of transistors, and arrangements in the U.K. have passed beyond the stage of laboratory experiments. Details of the writer's work in this respect have already been published; an accurate phase-comparator circuit which has been used in a transistorized carrier scheme is shown in Fig. 3. Note that American static phase-comparison elements based on transistors and other static components have appeared on the market.

Conclusions

Recent work on the application of electronics to protection, but not by any means the whole of the recent work on static relays, has been with transistors. The future application of transistors can most clearly be envisaged in connection with carrier protection, one advantage outweighing all others. This is the great reduction in size, cost and complexity of power supplies.

For some time, limited frequency range and power handling capacity were severe limitations in developing new carrier apparatus based on the junction transistor, but there is now a wider availability of diverse types. Power handling capacity is still a difficulty, in that the reliability of transistors to handle the carrier output power is still unknown. Transistors that could be used for direct switching of circuit-breaker trip coils are not yet fully available, but are likely to be so in the immediate future.

Early experience is so encouraging that static relays for all relaying applications are likely to be widely adopted in the near future. Relays will be based on transistors or rectifier-bridge comparators as merited by particular protection and relaying requirements. THE END

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2. Long term fuel savings... $17,000 a year off your fuel bill (more or less, depending on size of preheater and application). What you save on fuel can pay for the Package Air Preheater within two years.

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Completely pre-assembled Package Air Preheater is lifted into place at the new plant of Clearwater Finishing, (Division of United Merchants & Manufacturers, Inc.) at Clearwater, South Carolina. Installed at far less cost than a unit requiring on-site erection, this Package Air Preheater will serve a 83,000 lb/hr boiler. It measures approximately 8'x8'x6', and its 4900 sq ft of effective heating surface will recover 290°F from the stack gas.

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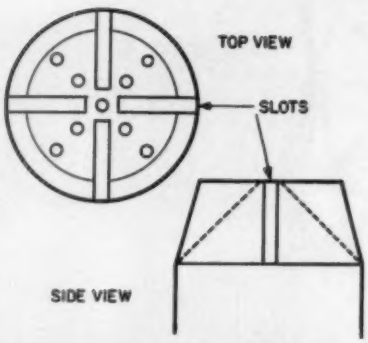
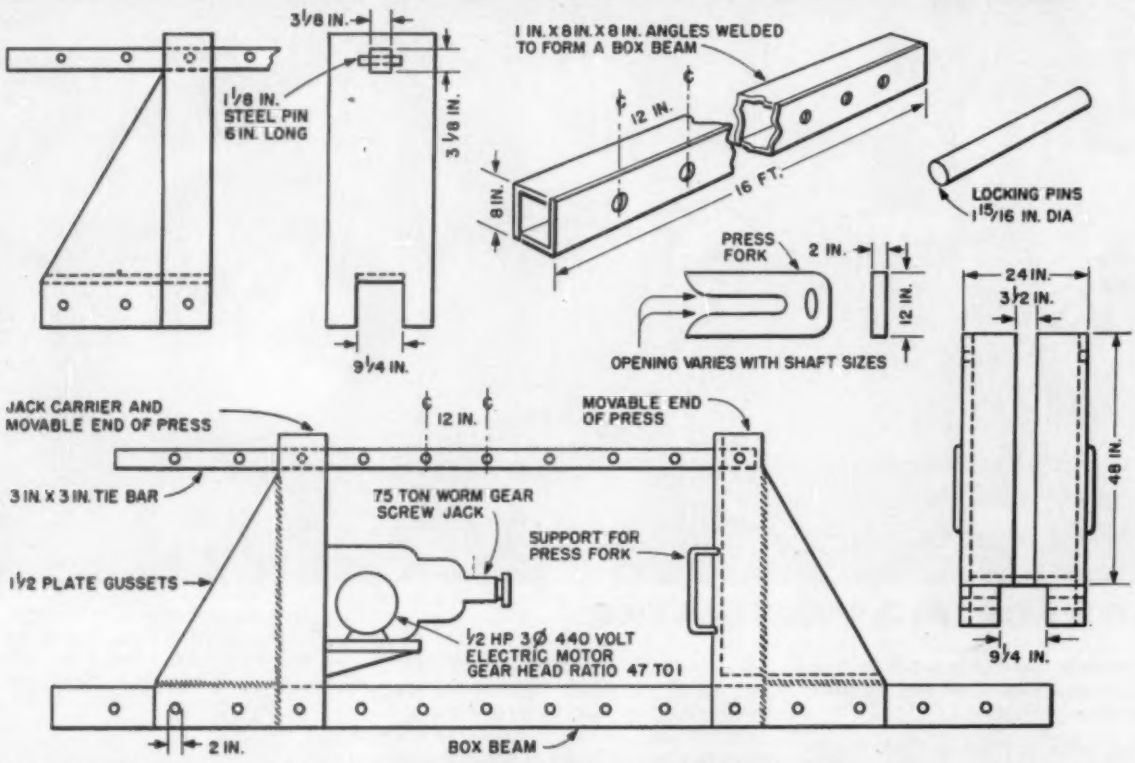
Making That Welding Tip More Efficient

By STAN CLARK

HERE'S AN IDEA we have found useful to our oxy-acetylene welding work. It reduces the time required for cleaning the slag out of the preheat holes in the welding tip.

Hacksaw a 45-deg slot between the preheat holes, nearly up to the oxygen holes, making the slot ⅛-in. deep at the outside edges on the burner face. Then you will find that, especially when making the starter hole in thick steel plate, the slag blows back as the oxygen is turned on and travels up these slots and thus doesn't plug up the preheat holes. Also, we find that the slag is easier to remove from the tip.





How We Made a 75-Ton Horizontal Press for Under $300

By D. K. SMITH

DRAWINGS reproduced here show how we made a 75-ton electromechanical horizontal press from materials salvaged from the scrap yard. Total labor cost was less than $250. Materials, including motor and jack, cost less than $50.

Our repair shop had never had a press that would handle large gears or sprockets. Such work had to be sent out. With our home-made press, first day's operation, in salvaged sprockets alone, paid the labor cost of the press fabrication.

Because of the power of this design, it is necessary to keep heater strips low enough so that jack casting will not fail. Speed of jack is about ¾-in. per minute. Center of press is 18 in. above top of box beam. Outside dimensions of press fork are held with center opening varying for different shaft sizes.

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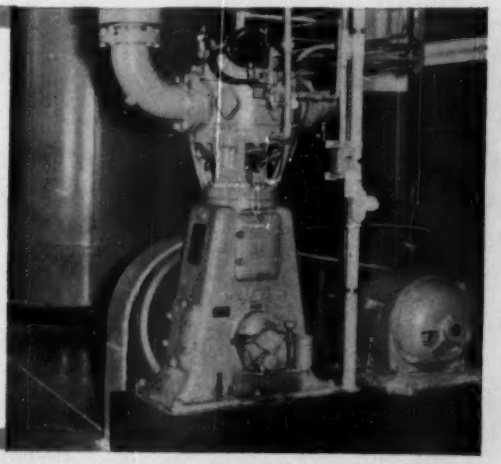
JOY WGO-9 Compressors

Because the Joy WGO-9 oil-free compressor is designed vertically, carbon ring wear is greatly reduced. Equal pressure on all sides of the piston rings produces even wear and reduced maintenance. The piston need never be rotated.

All Joy oil-free compressors are equipped with carbon graphite piston rings of an exclusive T-block design. They require no lubrication and compensate automatically for wear so that blow-by is virtually eliminated for the life of the ring. Joy compressor owners report ring life of 8000 operating hours or more.

WGO-9 compressors are available from 95 to 1528 cfm, 15 to 150 hp. Joy also builds complete lines of larger oil-free units including centrifugal and axial types as large as 15,000 hp. For complete information on the WGO-9 write for bulletin 2415-56C.



This WGO-9 supplies oil-free air for instruments and controls at a large central station powerhouse of a mid-western utility.

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Case of the Leaning Ice Tower

By C. T. BAKER

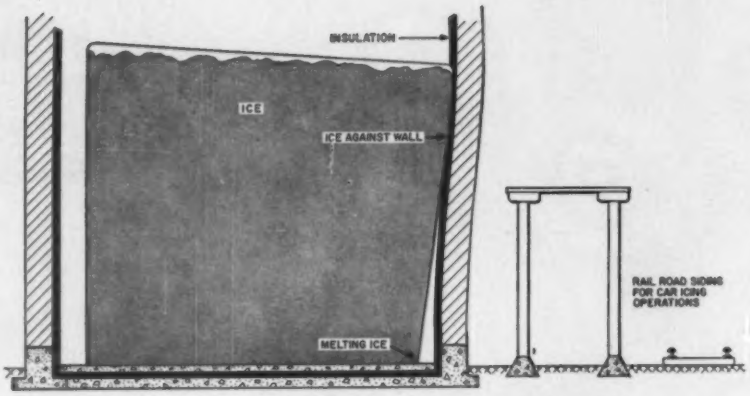
A LARGE ice storage building, designed to furnish ice to car-icing operations, was badly damaged by the movement of a column of ice that resulted from meltage at the floor line along much of the length of the east side of the structure.

The room had been filled to capacity early in the year in anticipation of a heavy movement of early crops. The demand was less than expected for the early crop movement. At the end of the early shipments, the storage was still slightly more than half full.

To be prepared for the icing demands of later crop movements, the room was filled to capacity, the new ice being placed on top of the original. Again, the demand was much less than expected. The management decided to carry the remaining ice over until the following spring and use it to take care of the icing demands at that time.

Several weeks following the storing of the new ice, the room being closed to await the coming of another season, it was discovered that the east wall of the structure was badly bulged and threatening to collapse.

External shoring was out of the question since the building was within a few feet of the railroad siding as well as of the main line, which handled heavy traffic 24 hours a day. Since shoring the wall was out of the question, the only solution was to tie the structure together with steel cable. It was also evident from the bulged wall that there was no time to lose if property damage and possible loss of life were to be avoided.



After collecting all the steel cable available, mostly half-inch with some three-eighths amounting to several hundred lineal feet, the structure was bound tightly together and held in place until the ice could be removed.

Several 8- by 10-in. timbers were placed against the east wall extending from the ground to the top of the wall and pulled tightly against the wall for its full length. Fortunately, there were several locations along the west wall where cables could be securely anchored.

When the layer of ice immediately in contact with the floor was uncovered, it was found to have melted in a direction which allowed the mass of ice to settle and finally contact the wall and exert a pressure beyond the ability of the wall to withstand without severe damage to its upper half section. External heat leakage to the building at ground level was due to a defect in the floor insulation along the east wall.

General arrangement of the building and car-icing platform is shown in the figure. What had all ingredients of a disaster of the first magnitude was eliminated by round-the-clock work of the operating personnel.

Use a Little Imagineering

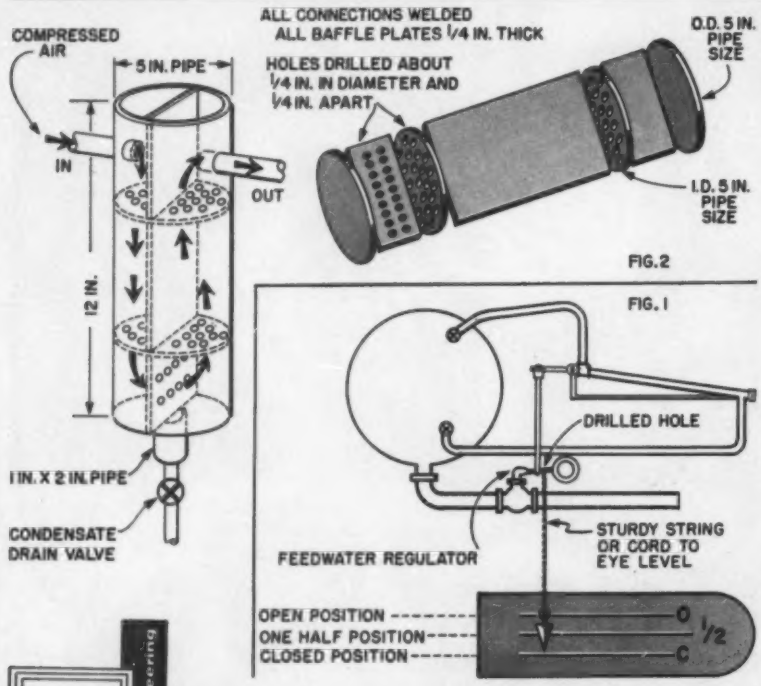
By TOM MULLIN

OFTEN the feedwater regulating valve is placed high above the operating platform, making it difficult for the engineer to determine if the valve is in an open or closed position. A sturdy cord attached to the valve lever arm, with a bob and indicator board (Fig. 1) will prove helpful in determining the valve's position without having to climb up on top of the boiler.

Figure 2 shows our solution to another problem. We were having difficulty with condensate in compressed air lines located a distance from the compressor. We cut a 5-in. by 12-in. section of pipe, and arc-welded two baffles with holes in the horizontal position, and a vertical baffle; also a top and bottom cover.

Air comes in one side, is forced down through baffles, then up through baffles and out to system. Condensate is drained daily out of the valve in bottom head.

This device really knocked down our condensate problem.



HANDBOOK

Power Engineering

As a public service to those in business and industry who are responsible for the protection of lives and property from the hazards of fire.

FIRE RESISTANT INCOMBUSTIBLE FLAME RETARDANT FIRE PROOF PROVE IT! FLAME-PROOF NON-FLAMMABLE

MATERIALS FOR PROTECTION OF THERMAL INSULATION AGAINST FIRE DAMAGE

FIRST, to clear up a common misconception about materials used to protect thermal insulation; no coating, sealer, or adhesive can by itself prevent fire damage. In fact, certain products without fire-retardant properties many times will actually cause fire and flames to spread; while products containing fire-retardant properties can at best only retard the spread of flames by the reduction of available fuel.

Over the years many ambiguous and ill-defined terms have been used to describe fire resistant properties of materials in literature, specifications and other published data. Words and phrases such as incombustible, flame-proof, non-flammable, fire resistive, and even fireproof have been attached to products used for the protection of thermal insulation. In many cases where the use of these terms was based on unrecognized and inadequate test methods, the products actually fed fuel to the flames rather than retarding them.

The only accepted measure of fire hazard in coatings is the flame-spread value. The confusing phrases used above do not give in exact terms the flame-spread value. If the confusion is to be eliminated, Industry must adopt a standardized system of testing and terminology for use in Engineering Specifications.

The use of confusing terms can be discarded by the adoption of the rating standard known as the Flame-Spread Index, accepted and used by building codes and insurance underwriters. There are two test methods accepted by Industry for determining flame-spread values. These are the Underwriters' Laboratories' "Tunnel Test" (ASTM E84) and the National Bureau of Standards "Radiant Energy Test" (Interim Federal Standard .00136–Com. NBS). With either of these established methods, flame-spread values ranging from zero to over 200 can be determined with accuracy for all coatings, adhesives and sealers used with thermal insulation materials.

An example of flame-spread values:

A totally incombustible material such as portland cement would have a flame-spread value of zero, while a self-extinguishable synthetic resin product could be rated about 60, and a violently combustible nitrocellulose product would be rated at "over 200."

Here, also, are the flame-spread values of some popular insulation weathercoatings applied over calcium-silicate insulation:

VAPOR BARRIER ASPHALT MASTIC	
Product A	175
Product B	173
Foster C. I. Mastic 60-26	170
FIBRATED ASPHALT EMULSION MASTIC	
Product A	218
Product B	200
Foster H. I. Mastic 90-07	150
FIBRATED POLYMER EMULSION MASTIC	
Product A	290
Foster Sealfas Mastic	40
FIRE RESISTIVE VAPOR BARRIER MASTIC	
Foster Fire Resistive Mastic 60-60	35

The Solvent Problem

Flame-spread values of solvent type mastic weathercoatings are determined under solvent free conditions to simulate service conditions existing after the products have been applied and all traces of solvent have evaporated. However, during application and cure, a fire hazard will exist when flammable solvents are contained in the coating. Such solvents having a flash point lower than 100° F. are flammable and easily ignited by welding sparks, matches, electrical sparks, cigarettes, etc. Thus a product, whose flame-spread index under solvent free conditions is relatively low, could well be the cause of a disastrous fire while it is being applied if it contains a flammable solvent.

Therefore, for complete fire safety, where welding and other sources of sparks and flame cannot be avoided during application of coatings and adhesives, these products should be chosen not only for their ultimate flame-spread value, but also for their formulation with non-flammable solvents (for example, Foster Fire Resistive Mastics).

Recommendations

We urgently recommend that engineers who specify fire resistive coatings, sealers and adhesives for use with thermal insulation specify maximum acceptable flame-spread values and flash points of materials. Only by rigidly adhering to such specifications will owners, their inspectors, buyers and applicators obtain fire safe thermal insulation construction.

A Word of Caution

The mere publishing of a flame-spread value is insufficient evidence on which to choose a product. Where two products, equivalent in every other respect, are offered for fire safe service, a product with a flame-spread value of 6 should unquestionably be chosen over a product whose index is 44. *Relative* flame-spread values, then, become of vital importance in choosing fire-retardant products.

Purpose

We at the Benjamin Foster Company have been devoting many years to research, study, manufacture and promotion of fire safe products for use in the protection of thermal insulation. We have adopted a firm policy regarding our promotion of fire safe products which is:

"To cooperate with all interested individuals and organizations in the establishing of a standardized system of testing and rating true flame-spread value . . .

To publish information that will be factual and in accordance with accepted practices . . .

To avoid overemphasis of disaster conditions in the promotion of fire safety . . .

To continue our research and development of products with improved fire safe characteristics."

If there is any way we can be helpful to you or your organization in a better understanding of products for use in the protection of thermal insulation, please contact your nearest Foster Representative, or write Benjamin Foster Company, 4635 W. Girard Avenue, Philadelphia 31, Pa.

foster COATINGS · SEALERS · ADHESIVES for thermal insulation

DIVISION OF AMCHEM PRODUCTS

For more data circle 536 on Post Card

Getting at That Lower Follower Gland

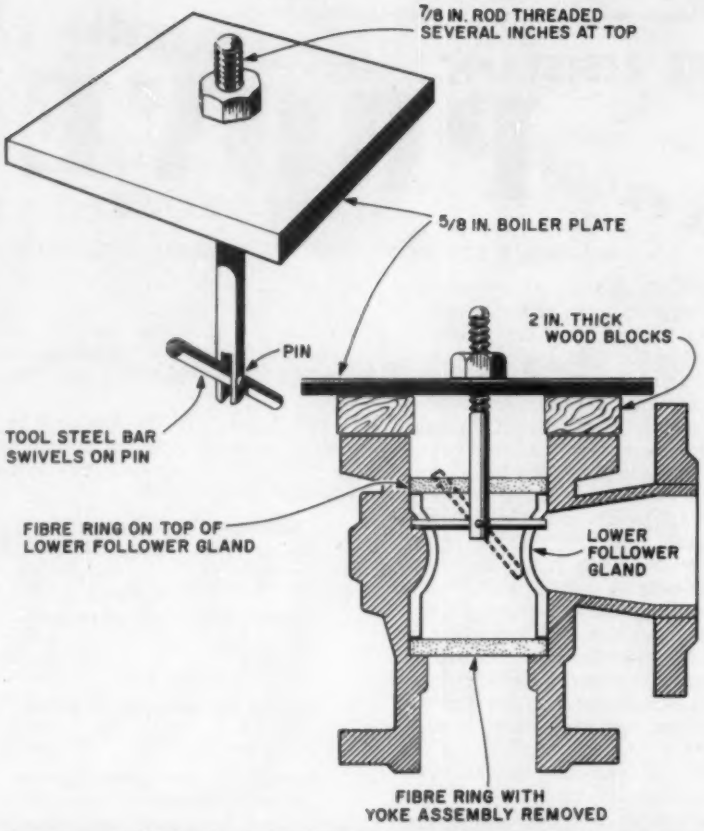
By VERNON AKIN, ass't chief power plant engineer, Louisiana Mill International Paper Co, Bastrop, La.

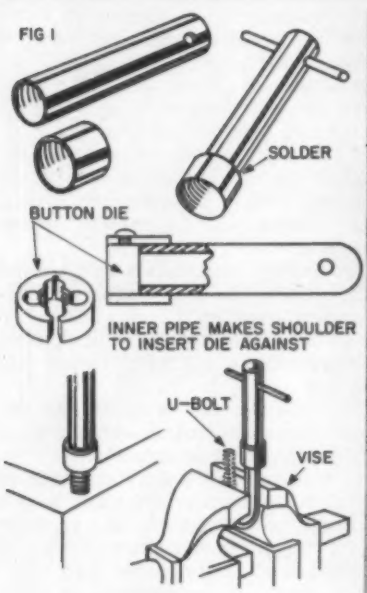
LOWER FOLLOWER GLAND in seatless blowdown valves is sometimes hard to remove for repair. Here's a simple-to-make tool that will pull it right out.

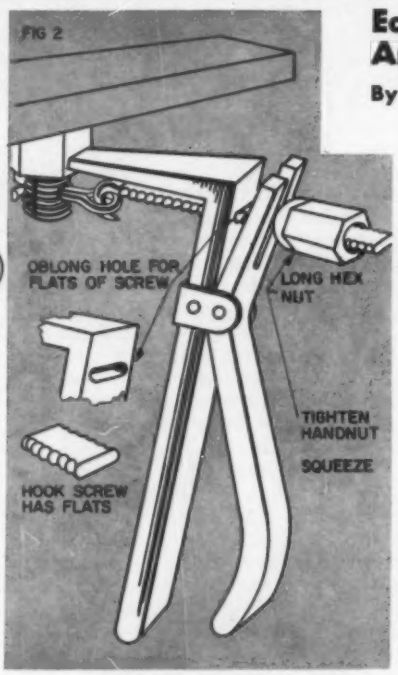
Use a ⅞-in. steel rod the proper length for your valve, and thread it several inches at the top end. Saw a slot in the other end of the rod to accommodate a tool steel bar which will swivel on a pin. After inserting the pin through rod and bar, brad it to prevent loss of bar.

Inserted in the bottom half of the blowdown valve, the gadget looks as shown in the figure. Tool steel bar swivels on the pin to allow it to swing into place. Wood blocks are placed on top of body of the valve, and a piece of boiler plate is laid on the blocks. The ⅞-in. rod is then passed through the center hole. When the nut is tightened, the swivel bar will force the lower follower gland out, along with upper fibre ring. Lower fibre ring can then be removed from above or below.

Keep the gland remover gadget in the repair shop where millwrights have access to it.


7/8 IN. ROD THREADED SEVERAL INCHES AT TOP
5/8 IN. BOILER PLATE
2 IN. THICK WOOD BLOCKS
PIN
TOOL STEEL BAR SWIVELS ON PIN
FIBRE RING ON TOP OF LOWER FOLLOWER GLAND
LOWER FOLLOWER GLAND
FIBRE RING WITH YOKE ASSEMBLY REMOVED





Easy-to-Make Cotter Puller And Die Holder

By CHARLES H. WILLEY

THERE ARE TIMES when one needs to rethread a stud or run over the threads of a small U-clamp or shackle and in such cases the two-handle die holder cannot be used. It's very easy to make a die holder from two different sizes of pipe as shown in Fig. 1. Select a section of pipe that fits the die diameter, cut off a ring of the right depth and drive this ring over the next size smaller pipe. Solder it as indicated, cut the smaller pipe to length desired and drill for a T-bar. Then you have a button die holder that can be used in close quarters.

Try making the shop-designed cotter key puller shown in Fig. 2. It works very well in places where such cotters are not easy to pull. In use, the cut-off hook screw is hooked into the cotter eye, and the hex nut is tightened as the nose of the tool bears against the work. Next, the leverage hand grip is applied and the cotter pulled part way out. Then repeat, tighten the hex, and finish pulling the cotter.

Power Engineering HANDBOOK

Why Every Steam Heated Unit Needs its Own Steam Trap

. . . the theory, practice and proof of "unit trapping" for top temperatures

Using an individual trap for each steam heated unit, including each separate coil, chest or chamber of a machine—pays off for the user. Here are just two examples:

1. On a creamery dryer

Drainage Method	*Air Temperature*
Restricted Blow-thru	250°
Group trapping (1 trap for 8 coils)	225°
Armstrong Unit Trapping (8 traps—1 for each coil)	**309°**

2. On a platen press

Drainage Method	*Processing Time*
Restricted Blow-thru	50 minutes
Group Trapping	35 minutes
Armstrong Unit Trapping	**25 minutes**

Why Unit Trapping Works Best

It is reasonable to assume that no two steam heated units will have *identical* condensing rates. Even the slightest difference in rate will cause a difference in steam pressure drops through the units. Here's where the trouble starts. Condensate from each unit may flow to the trap. But, what about air and other non-condensibles in the system? A difference in pressure drops too small to be indicated by an ordinary pressure gauge will permit backflow of steam from the higher pressure units to the lower pressure units. This backflow of steam may even impede flow of condensate from the lower pressure unit to the trap . . . and it will definitely impede or block off flow of air to the trap. The result is sluggish heating, reduced temperatures, reduced output, fuel waste and increased possibility of corrosion. Figures 1, 2 and 3 diagram the action.

Unit Trapping Not Costly

No engineer wants any more mechanical devices in his plant than are absolutely necessary. But, the moderate additional cost of using two or more small traps, instead of one big one, is saved over and over again in improved efficiency.

If the traps are Armstrong, maintenance is no problem. And users frequently tell us that Armstrong traps outlast others two and three to one.

Steam traps usually represent a fraction of 1% of the cost of the equipment they drain. Does it make good sense to lose 10% or more of equipment capacity to save a few dollars on traps?

Why not test Armstrong unit trapping in your plant. If you are not completely satisfied with the results you can return the traps for a full refund of the purchase price. There is little to lose—lots to gain. Call your local Armstrong Factory Representative or Distributor, or write **Armstrong Machine Works, 8105 Maple St., Three Rivers, Mich.**

ASK FOR the 44-page Steam Trap Book and reprint of article on Unit Trapping.

8015T

ARMSTRONG STEAM TRAPS

How Different Condensing Rates Can Slow Production

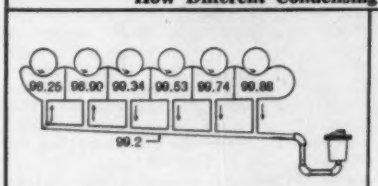


Fig. 1 This is a 6-roll ironer shortly after it has begun operating on 100 psi steam. When cold, wet material passes over chest 1, steam condensing rate is high and pressure drops accordingly. The pressure drop in chest 2 will not be as great, and so on down the machine as the material becomes progressively hotter and drier. Average pressure in the chests then is 99.27 lbs., and drain header pressure is slightly less, about 99.2 lbs. Under these conditions, steam from drain header enters chests 1 and 2 (as indicated by arrows at side of drain lines) because of pressure difference. Though condensate from chests drains by gravity, air can't leave chests countercurrent to incoming steam. Fig. 2 shows what happens next.

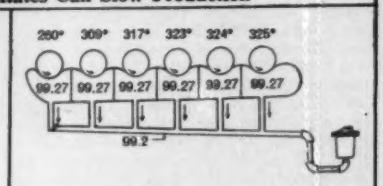


Fig. 2 This is the same 6-roll ironer after it has been operating a while. Air has accumulated in chests 1 and 2, reducing condensing rate and decreasing pressure drop. This process repeats itself down the line until pressures are as shown—that is, enough air will accumulate in each chest so that condensing rates and pressure drops of all chests will be about equal. The net result is shown in chest temperatures which are actual pyrometer readings taken on a 6-roll ironer, drained by a master trap, in a Chicago laundry. The laundry was making 337.9°F steam, but getting an average of only 309.6°F from the ironing surfaces, necessitating slow operation and frequent reruns. Then they tried Armstrong unit trapping—see Fig 3.

How Unit Trapping Prevents Trouble

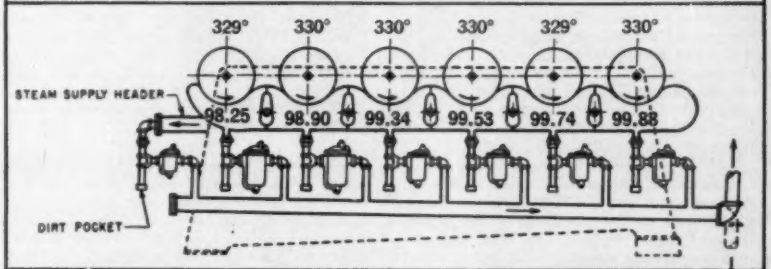


Fig. 3 This is the same 6-roll ironer, now unit trapped. Temperatures shown are also actual pyrometer readings—the average of 329.6°F is 20° higher than with group trapping. This is because air is continually removed from each chest into the drain header, and cannot get back into any chest.

For more data circle 537 on Post Card

CONSTRUCTION NEWS

Birmingham, Ala. — Alabama Power Co, Alabama Power Bldg, has announced that it has received permission from the Federal Power Commission to proceed with Project No. 2, which includes the raising of Jordan Dam approximately seven feet, installation of a powerhouse, and installation of a five-mile canal. Work will begin at once and will cost approximately $33,000,000 when completed in 1963. Company also plans to increase generating capacity of this plant to about 119,000 kw at an additional outlay of $740,000. At the same time, company has announced that the dam at Wetumpka, Elmore County, will be abandoned.

Palmer, Alaska — Matanuska Electric Association, Inc, this city, has plans in progress for the installation of new distribution lines, tie lines, transformers and increased substation facilities to serve an ever-expanding list of new customers. Work is already under way and is scheduled for completion in the fourth quarter of 1961. Cost is reported to be approximately $1,215,000.

Oroville, Calif. — Oroville-Wyandotte Irrigation District, P.O. Box 229, has announced that it has finally sent construction crews to work on California's long-delayed irrigation and hydroelectric project on the south fork of the Feather River. Work will include four earth and rock-fill dams, three concrete dams, 17 miles of tunnels, 11,000 ft of penstocks, three hydroelectric plants, 23 miles of power and irrigation canals, access roads, etc. Cost of the project when completed in 1963 will be well over $50,000,000. Bechtel Corp, San Francisco, Calif, is the consulting engineer on the project. Initial work contract was awarded to a five-company combine headed by Guy F. Atkinson Co, of the same city.

Hartford, Conn. — Connecticut Light & Power Co, 266 Pearl St, has announced a proposal to the directors of the Housatonic Public Service Co that the two utilities affiliate either by merger or an exchange of stock on the basis that the proposed merger would be advantageous to customers and stockholders of both companies. Companies serve adjoining areas in the state, and for a number of years Connecticut Light & Power has been providing major part of Housatonic's power requirements in the western part of the state. Connecticut Light & Power Co proposes to issue 1.4 shares of its stock for each share of Housatonic's common shares.

Shelton, Conn. — Housatonic Public Service Co, 133 Elizabeth St, Derby, Conn., has authorized plans for the construction of a new power plant near here, which will include the installation of two 100,000-kva turbine generators, high-pressure boilers and auxiliary equipment. Work, reported to cost in excess of $31,000,000, will include necessary substation installations and erection of new transmission lines. Work will begin when preliminary engineering work is completed and is targeted for completion late in 1963. Gibbs & Hill, New York, N. Y., is consulting engineer and architect of the new plant.

Tampa, Fla. — Tampa Electric Co, Cass & Tampa sts, has announced the purchase of a large plant site consisting of 150 acres on which it proposes to construct a new coal-fired power plant in the near future. Tampa and Peabody Coal Co recently purchased on a 50–50 basis two coal-hauling firms from Virginia-Carolina Chemical Corp; namely, Gulfcoast Transit Co and Mid-South Towing Co. The firms were formed in 1959 to haul coal from the Green River coal area in western Kentucky to Tampa, Fla., and phosphate on the back-haul to New Orleans. The two water carriers carry approximately 500,000 tons annually, but by 1963 will increase that amount to 1,200,000 tons under a supply contract with Tampa Electric.

St. Petersburg, Fla. — Florida Power Corp, 101 S. Fifth St, this city, has authorized plans for the installation of a second steam-electric generating unit, with high-pressure boilers and auxiliary equipment at its Bartow Power Plant, located on Weedon Island, here. Work is already under way and is scheduled for completion by the summer of 1962. Cost when completed is reported to be in excess of $10,000,000. Work will be under the supervision of Black & Veach Co, Kansas City, Mo.

Marion, Ill. — General Services Administration, Public Buildings Service, Washington 25, D. C., has authorized plans for the construction of a maximum-security penitentiary of concrete and structural steel framing, an administration building, boiler house, garage and fire station at a location here. Plans also include a chapel, hospital, warehouse, library, cell buildings, towers and officers' shelters. Work is scheduled to begin soon for completion late in 1962.

Forest City, Iowa — City Hall, Forest City, Iowa, has authorized plans for the construction of an outdoor electric substation, a 69-kw terminal structure, two power transformers and metal-clad switchgear for municipal power system. City has awarded a contract in the amount of $122,100 to the Trans-American Constructors, Inc, Pittsburgh, Kans., for the work which will be done under the supervision of Stanley Engineering Co, Muscatine, Iowa, engineers.

Columbia, Mo. — City Council, City Hall, has plans in progress for expansion and improvement in municipal power plant, with the installation of a 22,000-kw generator and accessories, a 220,000-lb boiler with auxiliary equipment, coal bunkers, electric power interchange and installation of additional distribution facilities. Work will begin at once under supervision of Lutz & May Co, 819 Finance Bldg, Kansas City, Mo., consulting engineers. Work will be completed late in 1962; cost is reported to be approximately $5,000,000. Appropriation will be raised through bond issue.

Rowe, Mass. — Yankee Atomic Electric Co, a jointly owned enterprise of ten New England utilities, headed by New England Electric System, has announced that it has started testing its 136,000-kw pressurized-water reactor. Construction of the $50,000,000 power plant began in the spring of 1958. Following a period of low power tests with no steam delivered to the turbine generator, the plant is scheduled to begin generating electricity in a step-by-step buildup to full power which company expects to attain by the first quarter of 1961. Company has recently received a provisional license for power operation up to 110,000 kw. Application will be made at a later date for a permanent full power license for 136,000 kw.

Sibley, Mo. — Missouri Public Service Corp, Hout Bldg, Warrensburg, Mo., has announced contract awards totaling approximately $1,000,000 for work in connection with its new steam-electric generating installation here. Work will include installation of the substructure, installation of high-pressure, high-temperature piping, turbine, condensers, boiler feed pump, and electric wiring and electric system for generating unit control panel. Installation is scheduled for completion by the third quarter of 1962.

Goldsboro, N. C. — Carolina Power & Light Co, 419 Fayetteville St, Raleigh, N. C., has authorized contract award in the amount of $8,000,000 to the Ebasco Services, Inc, 2 Rector St, New York, N. Y., for design and construction of its Quaker Neck steam-electric plant addition, here. Work includes installation of a steam-electric generating unit with an initial capacity of 320,000 kw, high-pressure boilers and auxiliary equipment for increased capacity. Work will be completed by the spring of 1963.

Roanoke Rapids, N. C. — Virginia Electric & Power Co, Seventh & Franklin sts, Richmond, Va., has authorized plans and work has begun on construction of its Gaston hydroelectric plant here. Facility includes the installation of four electric generators, each with a capacity of 50,000 kw, and eleven radial flood gates on its concrete spillways. Work is proceeding according to plan and is scheduled to be completed late in 1963. Cost is reportedly about $50,000,000. Stone & Webster Engineering Corp, Richmond, Va., has been awarded a contract to design and construct the facility.

Knoxville, Tenn. — Tennessee Valley Authority, New Sprankles Bldg, has announced that it is contemplating the use of steam-electric generating units with a capacity of 800,000 kw to meet the rising need for electric power in its area. This would be the first such installation of its kind ever built. Plant location to house such a facility has not as yet been determined, but TVA engineers have been conducting studies for several months in eastern Kentucky and Tennessee on potential sites which would offer maximum use of the area's extensive coal reserves. Plans are still in the initial stage, but TVA anticipates that growing power demands will make it necessary to start construction of the first unit by the summer of 1961.

Oak Ridge, Tenn. — Tennessee Valley Authority, New Sprankles Bldg, Knoxville, Tenn., has announced contract award to the Baldwin-Lima-Hamilton Corp, Philadelphia National Bank Bldg, Philadelphia, Pa., in the amount of $1,846,560, for hydraulic turbines for TVA's Melton Hills Dam now under construction. Work is well under way and is scheduled for completion late in 1962.

Continued on page 97

Utilizes Westinghouse silicon high-voltage rectifier cells

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You get more power...reduce maintenance...increase reliability when you convert to Buell Silicon Rectifier Units

Buell Silicon Rectifier units can increase efficiency of your rectifiers 25% or more ■ Perfected and specifically designed for fast, simplified conversion of existing mechanical or tube rectifiers ■ They cut operating costs, reduce overall maintenance ■ Enable more efficient utilization of power ■ Eliminate rectifier maintenance ■ Reduce outages ■ Reclaim plant space ■ Suitable for indoor or outdoor installation ■ For only a small investment you can materially improve your rectifier performance ■ For details of the unit and a specific proposal write: Buell Engineering Co., Dept. 52-K 123 William Street, New York 38 ■ Northern Blower Division, 6434 Barberton Ave., Cleveland, Ohio ■ CYCLONES, ELECTRIC PRECIPITATORS, BAG COLLECTORS, COMBINATION SYSTEMS, CLASSIFIERS, FANS.

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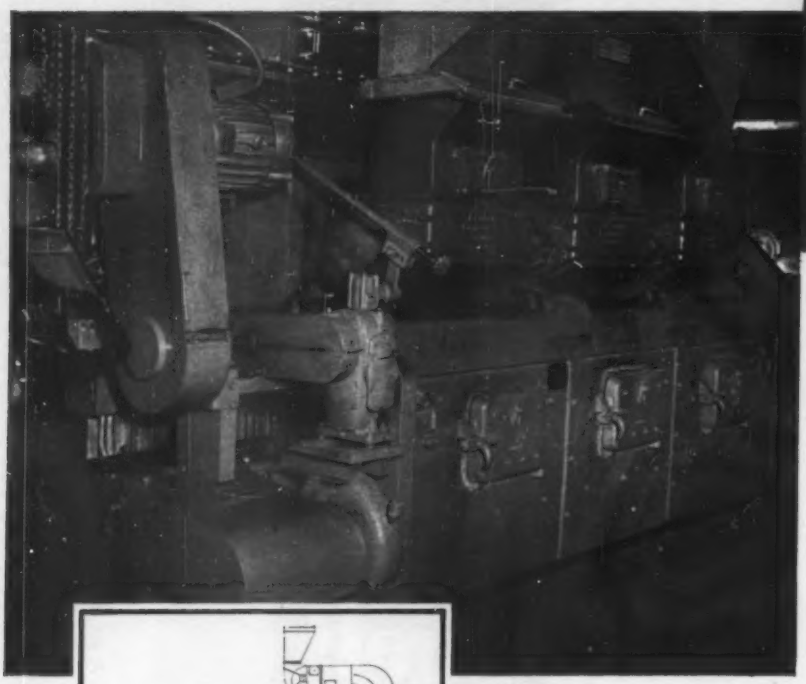
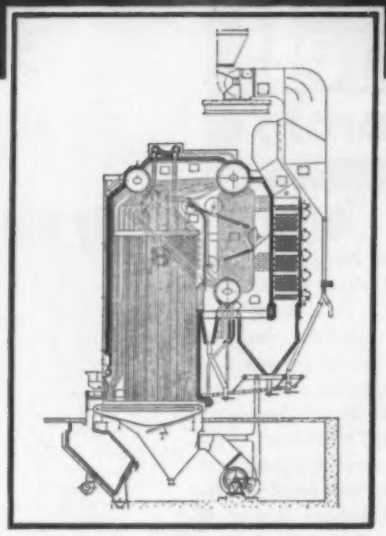
Availability?...

HERE'S A RECORD TO SHOOT AT..

....Only 5 HOURS OUTAGE in 5 years



A Detroit RotoGrate Stoker



AT OTSEGO

Detroit RotoGrate Stoker with Wickes Boiler; 650 pounds pressure, 750°F temperature. Cummins & Barnard, Consulting Engineers.

This record of only 5 hours outage in over 5 years is reported by Otsego Falls Paper Mills, Otsego, Michigan, a division of Menasha Wooden Ware Corporation.

Walter Boettcher, Chief Power Engineer says: "*5 hours in 5 years and 4 months is the record of down time due to the RotoGrate Stoker outage*" in this well operated single boiler plant.

"*It operates 24 hours a day—5 to 6 days a week, 60,000 to 90,000 pounds of steam per hour.*

"*Paper mill load fluctuations handled easily without pressure loss.*"

This record indicates a fine job of equipment maintenance, but high availability can be taken for granted with the DETROIT ROTOGRATE.

A customer survey taken in all kinds of plants proves it.

DETROIT ROTOGRATE COSTS LESS

Cost = initial investment + upkeep + production losses due to outage of equipment. The total is less with RotoGrate.

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CONSTRUCTION NEWS

Continued from page 94

Daingerfield, Texas — Southwestern Electric Power Co, 428 Travis St, Shreveport, La., is considering plans to construct a hydroelectric generating facility on the Lake O' the Pines near here. Construction of the new unit will begin in the spring of 1961 for completion by late 1963. Cost of the installation is reported to be over $6,000,000.

Greenville, Texas — Municipal Electric Department, City Hall, has approved plans for major additions and improvements to local municipal power plant with installation of a new generating unit for increased capacity. Work will include installation of new transmission lines and general plant improvement. Construction will begin at once for completion about May 1962. Cost of the new unit and general improvement program is reportedly about $1,400,000. Funds will be made available through bond issue.

New Engineering Books

Pressure Vessel and Piping Design, Collected Papers 1927–1959; 710 pages, 8½ by 11 in. Published by The American Society of Mechanical Engineers, 29 West 39th St, New York 18, N. Y. Price $10.

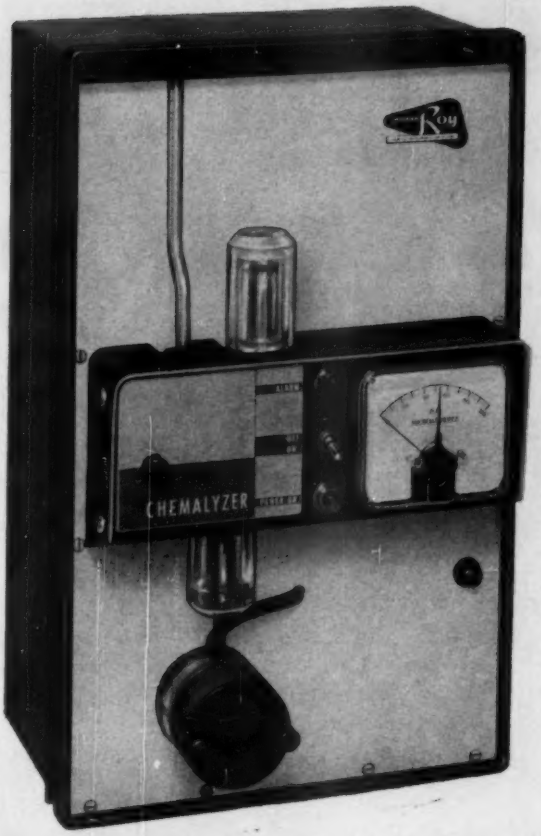
Brought together in one volume, a wealth of the most important literature in this area of study is presented in ten sections: Openings, Bolted-Flanged Joints, Heads, Shells, Piping, Materials and Fabrication, Thermal Stress and Fatigue, Loads and Supports, External Pressure, and Miscellaneous-Unclassified. Within each section the papers are arranged in chronological order of their publication. Papers and discussions are reprinted as originally presented.

★ ★ ★

Mechanical Design of Hydro Plants, Design of TVA Projects, Technical Report No. 24, Volume 3; 986 pages, 6 by 9¼ in. Published by United States Government Printing Office, Washington, D. C. Price $3.75. Copies may be purchased from the TVA Treasurer's Office, Knoxville, Tenn.

This is the third of three volumes comprising the Design of TVA Projects. The civil and electrical activities of the TVA's Division of Design have been covered in previously issued volumes: Vol 1, Civil and Structural Design; Vol 2, Electrical Design of Hydro Plants.

This third volume explains the engineering work involved in the design of the mechanical installations for the primary water control structures of TVA, including switchyards constructed at the generating stations. Appurtenances for the control of water, such as gates and cranes, are considered to be



ANALYZE for water hardness ...phosphates...residual chlorine AUTOMATICALLY ...ECONOMICALLY

Surprisingly simple, compact, and economical, new Chemalyzer* instruments automatically perform complete colorimetric analyses and accurately indicate results in ppm ranges . . . . even sound the alarm when pre-set limits are exceeded.

Chemalyzer instruments eliminate the wasteful and ineffective practice of limiting the capacity of the system in order to maintain proper control. With Chemalyzers on the job there's less frequent regeneration . . . less money spent on labor and chemicals. And you get a more dependable, full-capacity system.

The completely self-contained unit is easily installed and put to work in a matter of minutes. Few moving parts and rugged construction insure a long time on the toughest jobs without service problems. Typical analyses include water hardness, phosphates, residual chlorine, and other single reagent analyses.

GET FACTS ON Chemalyzer analyzers in Bulletin 858-1. Write Milton Roy Co., 1300 East Mermaid Lane, Philadelphia 18, Pa.

*Tradename

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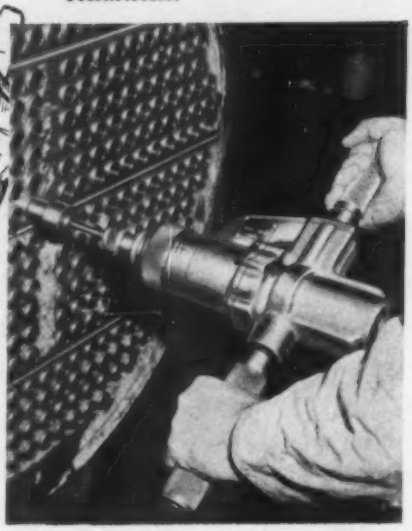
AIRETOOL stands up under torture

Yes sir! You can depend on Airetool for speed, accuracy and economy in tube maintenance

Airetool pneumatic tools—cleaners, drills, brushes and motors—are designed to meet the specific needs of refiners for efficient, low-cost tube maintenance and to do the job under the most difficult conditions.



For example, the AIRETROL Tube Expansion Control, illustrated at right, rolls up to 12 tubes a minute within .001 inch accuracy; maintenance costs drop and expensive tube failures are reduced. Labor costs are cut, too, because Airetrol's rugged, lightweight construction makes one-man operation easy.

And, one man can remove the hardest deposits and clean completely plugged tubes with Airetool's CC-475 Condenser Cleaner. The built-in flushing system keeps the drill cool and the cuttings washed away.

CC-475 CLEANER

If you're plagued by high tube maintenance costs, investigate the economies of Airetool tube equipment; it puts you on stream sooner and keeps you there longer. For full information write to:

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More than 30 years' experience in pneumatic tools

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.
Representatives in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii.
CANADIAN PLANT: Brantford, Ontario.
EUROPEAN PLANT: Vlaardingen, The Netherlands.

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accessories of the structures and were included in Vol 1. The book devotes 299 pages to a general description of the TVA system and to individual descriptions of the 23 projects that are essentially those designed and built by TVA. Six acquired projects are described briefly in six pages. The TVA system also includes 15 projects owned by ALCOA, and five projects owned by U. S. Army Corps of Engineers — these plants are simply listed.

Appendices: A. Hydraulic Turbine and Governor Data; B. Auxiliary Equipment Specifications; C. Heating, Ventilating and Air-Conditioning Equipment Specifications; D. Construction Specifications; and E. Operating Instructions.

★ ★ ★

Using Centrifugal Pumps, by E. Allen; 246 pages, 5¾ by 8½ in. Published by Oxford University Press, 417 Fifth Ave, New York 16, N. Y. Price $4.80.

This book deals with the centrifugal pump from the point of view of the operating and maintenance staff responsible for the efficient running of the pumps and their emergency repair or installation. Fundamental principles are explained, also pump characteristics, and numerous examples are presented showing methods of correctly choosing type and capacity for both permanent and emergency needs.

Some reference is made to methods of priming and automatic control, and to the full use of accessories. The author, who writes from a background of British engineering experience, has taken care to avoid complicated formulae, and to make this a truly useful book for the practical engineer on the job.

★ ★ ★

Thermal Engineering, by H. L. Solberg, O. C. Cromer and A. R. Spalding; 643 pages, 6 by 9¼ in. Published by John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y. Price $9.50.

This book is described as an outgrowth of *Elementary Heat Power* by the same authors; but it might better be considered as a third edition of the same text, since more than half of the subject matter is identical. The book itself is larger, the figures are larger, extra space is allowed between sections and illustrative examples are set in larger type. The over-all appearance and effect are considerably enhanced.

Aside from bringing figures on equipment sizes and design up to date, the greatest change is in the addition of descriptions of nuclear reactors under fuel-burning equipment, a treatment of nuclear reactions under combustion, and a new chapter on heat transfer.

The book provides a well-organized and clear presentation of elementary heat power.

★ ★ ★

Land, Wood & Water, by Senator Robert S. Kerr; 380 pages, illustrated; size 5 x 8 in., cloth binding. Published by the Fleet Publishing Corporation, 230 Park Ave-

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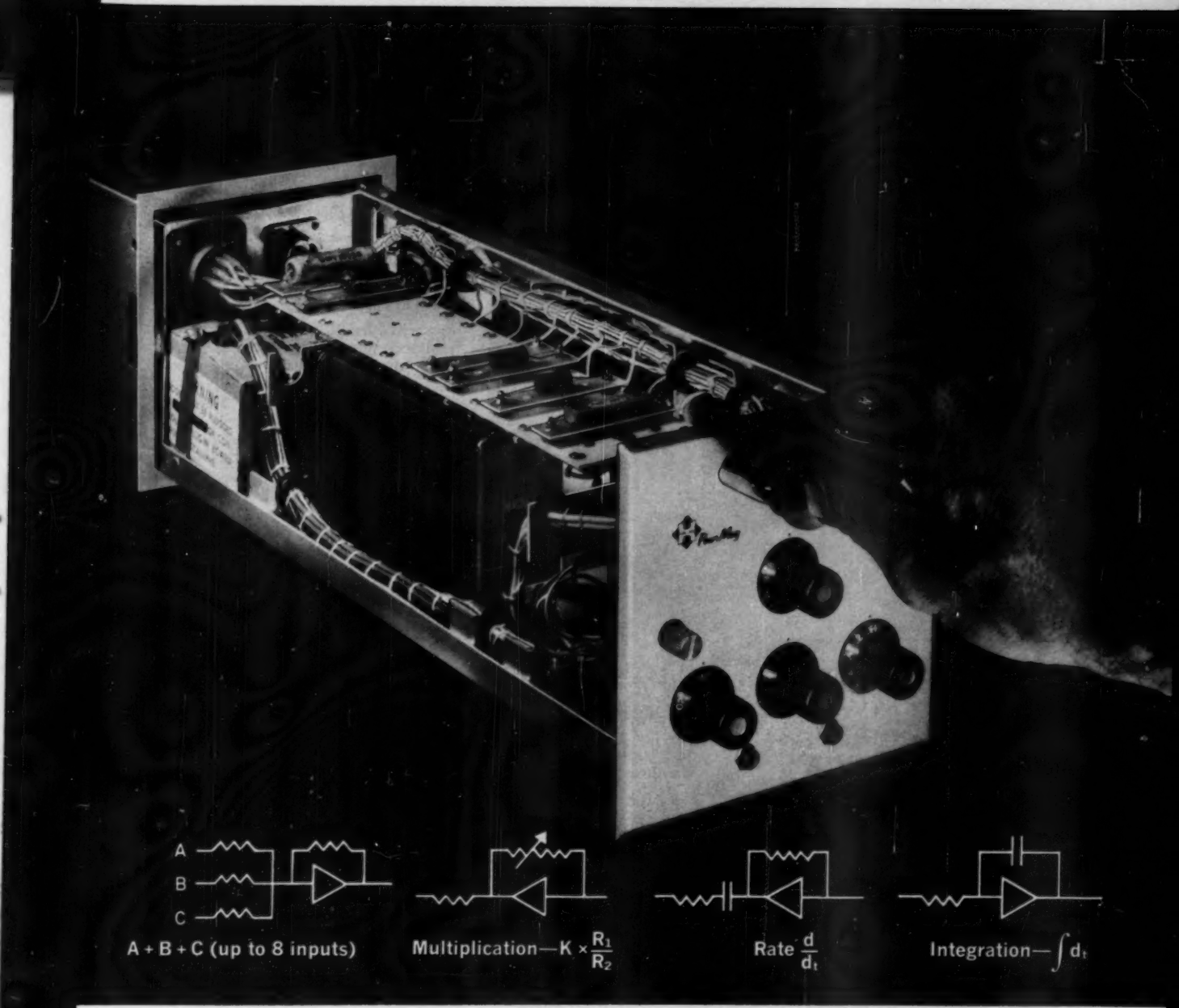
nue, New York 17, N. Y. Price is $4.95.

In the opinion of many of today's readers water management is our No. 1 economic problem. Secretary of the Interior Seaton has emphasized this again and again, and his Department has fostered several methods of producing usable water from sea water and other brackish waters across the country. Other Congressional leaders are vitally concerned with this whole problem of water supply for the nation, and some large-scale plans are afoot in various parts of the country such as the proposal for supplying water to the Central Valley of California.

None of these men, however, can surpass U. S. Senator Robert S. Kerr in his concern for what he considers a danger that threatens the Nation's economy unless there is an organized conservation plan for the protection and utilization of its natural resources. Wells can run dry, and civilizations can perish. The Senator is chairman of the Select Senate Committee on National Water Resources, which is at this moment making a survey of the entire country in an effort to determine what, if anything, can be done to unify the various efforts towards conservation of our water supply that are carried on literally by hundreds of local, state and regional organizations. The engineering profession, through the Engineers' Joint Council and its National Water Policy Panel (of which this writer has the honor to be a member) is offering its full coöperation to the Senator in all his work on this subject. Engineers in every field have a vital stake in it.

The Senator has written this book primarily for the general public to give them a full picture of its many ramifications. Beginning with an eloquent description of the miracles in the creation of the universe, the story moves down through the ages to dramatize the various benefits of modern flood control, navigation, power, recreation, soil conservation and municipal and industrial water developments. A man must still learn how to feed a growing population from land that erodes, to meet expanding housing needs from our vanishing timber, to sustain life on a water supply that is in danger of diminishing. In many respects there is plenty of water in the country, but much of it is not in the right place. Furthermore, the whole problem of water supply is tied closely to that of stream pollution. It must be understood that a great many people, not only in Government but among the general public, are fully aware of the problems of water supply and water pollution, and there is a great deal of activity in various quarters in trying to solve these problems. But much remains to be done, and the Senator has sounded the alarm and pointed to the dangers. He claims that very few communities in this nation have enough water to sustain even their present population on the basis of demands expected twenty years from now.

The Senator writes vividly with a sense of the drama and poetry that underlies his own and others' love of the rich earth.



MAGNETICALLY—ONE CONTROLLER for all control functions

Hagan's PowrMag controller combines the kind of reliability required by industry with a flexibility of application that makes this one controller suitable for all control actions. Utilizing a high gain, operational magnetic amplifier, PowrMag can produce the full range of control actions by simple negative feedback through ordinary resistors or capacitors. These "passive network" elements are simply and easily plugged into the basic amplifier chassis by means of an integral plug-board, as shown in the photograph.

Here are some of the characteristics that make the PowrMag so valuable to a control system designer . . . Control signals—1 to 9 v DC *(no noise, capacitive loss or phase shift problems)*—Entire amplifier potted and then encased in steel *(virtually unaffected by environment)* — Utilizes unregulated 110 v AC power supply *(uses only 3 watts of power)* —Full integration action from a minimum change *(high sensitivity)* —Modular construction *(no inventory problems—each unit can perform any given function by a simple change of plug-in components)* — Each module is equipped with a pilot light to indicate fuse failure, test jacks to plug in an output meter, calibrated knobs for set point (bias), gain, reset and rate. Components can be replaced without a soldering operation *(minimum maintenance)*.

The Hagan PowrMag line includes the controller, remote control stations, patchboards for interconnecting the system, sensing elements and final operators. Why not phone or write for a Hagan engineer to give you all the facts on this remarkable system.

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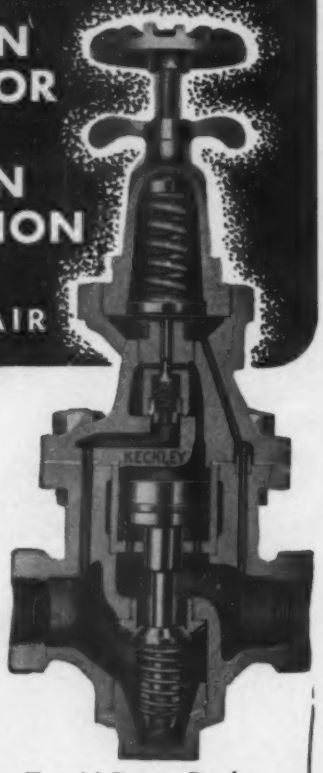
for STEAM or AIR



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FEDERAL AGENCY POWER NOTES

» **Federal Power Commission** reports that utility hydroelectric plants produced 12,446,738,000 kilowatt-hours in June, 10.6 per cent over the production from this source in June 1959. As a proportion of the June total, water power increased from 18.8 per cent last year to 20.1 per cent this year. Production by fuel-burning plants in June was 1.8 per cent above that for June 1959.

For the year ended June 30, twelve-month production totaled 733,571,-863,000 kilowatt-hours. This represents the highest total for any 12-month period and was 7.9 per cent above the 679,997,982,000 kwh for the year ended June 30, 1959.

Installed capacity of electric utility generating plants totaled 162,069,556 kw on June 30, a net increase of 789,427 kilowatts during the month. The June 30 capacity indicates a 1960 first-half addition of 5,447,464 kw from the preliminary total of 156,622, 092 kw in service on Dec 31, 1959, and a gain of 11,847,113 — or 7.9 per cent — from the June total a year ago.

Industrial generating capacity was 17,618,329 kw on June 30, and utility and industrial generating capacity totaled 179,687,885 kw.

» **Authorization** has been given to El Paso Natural Gas Co, El Paso, Texas, to construct and operate natural gas facilities to cost approximately $3,930,000.

Company will install an additional 6800 horsepower in its Goldsmith compressor station and will build facilities to provide an additional 58,800,000 cu ft per day capacity at its Goldsmith purification and dehydration plant. New facilities will be located in Ector County, Texas.

» **FPC has approved** five applications by four interstate natural gas pipeline companies for construction of new storage and transmission facilities, together estimated to cost approximately $58 million.

The case relates principally to applications by Texas Eastern Transmission Corp, of Shreveport, La., to transport and store natural gas in off-peak periods to provide a winter service to 23 wholesale customers in the Midwest and East, including New England. This service will make available a total maximum of 334,-036,000 cu ft of natural gas per day to the customers.

Texas Eastern's project is estimated to cost $40,668,000 and includes about 214 miles of 20 to 36-in. pipeline, a new 3300-hp compressor station, and two new metering stations.

Other companies affected by the FPC action are Algonquin Gas Transmission Co, of Boston, Mass.; Transcontinental Gas Pipe Line Corp, of Houston, Tex.; and New York State Natural Gas Corp, Pittsburgh, Pa.

» **Fuel consumption** by electric utility plants, for twelve months ending June 30, was: Coal, 171,933,489 tons; oil, 86,205,250 bbl; gas, 1,675,119,738,000 cu ft, the FPC disclosed.

» **Power revenues** of the Tennessee Valley Authority reached an all-time high of $242,385,000 for the year ended June 30, 1960. This compares with revenues of $237,540,000 for the year before. Net income amounted to $51,075,000; last year's net income was $50,830,000.

During fiscal 1960 Congress authorized TVA to issue bonds not to exceed $750 million outstanding at any time, to be used exclusively to help finance construction of additional power facilities. TVA announced it will sell publicly $50 million of power bonds, the first issue under this authorization, on November 15.

TVA's power sales increased 2.2 billion kilowatt-hours to a total of 59.3 billion. TVA, as wholesaler, and 153 local electric systems as retailers, supply power to 1,413,000 residential, farm, commercial, and industrial customers. Sales to these local distributors totaled 20 billion kilowatt-hours, up 13 per cent over the preceding year. Revenues totaled $85,416,000.

TVA also supplies power directly to 27 industries whose use of electricity is very large or otherwise unusual. Sales to these directly served industries rose nine per cent and totaled 10.4 billion kilowatt-hours. Revenues from these sales amounted to $43,270,000.

The Federal defense agencies served directly by TVA continued to account for nearly half of TVA's total sales; they purchased 28.3 billion kilowatt-hours for which they paid TVA $110,035,000.

Largest element in TVA's production expense, the cost of coal, totaled $82.6 million in fiscal 1960. TVA is the nation's largest purchaser of coal. The steam plants burned 18.6 million tons in 1960. Average fuel cost for the steam plants was 1.8 mills a kilowatt-hour, only 60 per cent of the 3-mill national average.

Payments in lieu of taxes by TVA

This maintenance engineer is

"Seveneering" with R/M

for his hydraulic packing needs

At the suggestion of his local R/M packing distributor, he is installing Big 7 Packing Type #7 (self-sealing, self-adjusting R/M Vee-Flex® rings) on the plunger of a freight-handling elevator. He will also use this R/M packing on his hydraulic rams, pumps, valves and accumulators. The unique design and construction of this packing will not only seal laterally against the stuffing box wall, but will also seal longitudinally against the next ring. This assures maximum sealing performance under any pressure without extrusion. And only a light gland adjustment is required to provide a positive seal.

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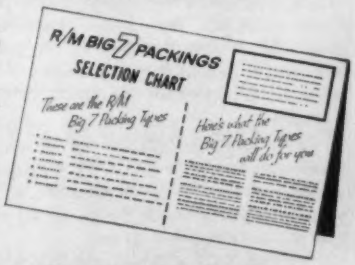
This new R/M Big 7 Chart is a mighty handy reference. Send for your copy now. →



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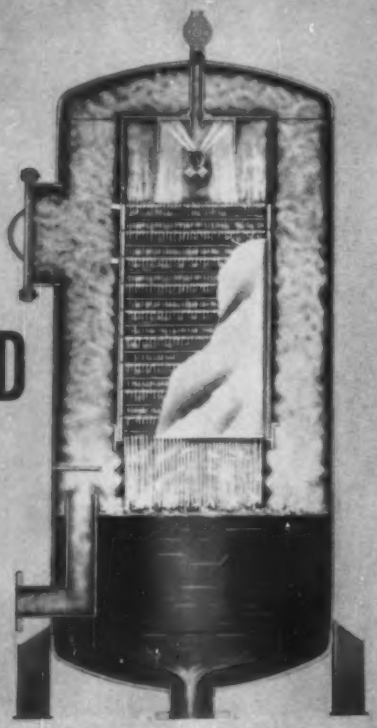
by this new Permutit® Tray Deaerator



The picture above illustrates the new Permutit Tray Deaerator, which is *guaranteed* to reduce oxygen to .005 ml/l, or less, and to remove all the free CO_2.

This sectioned illustration shows the stainless steel trays and inner chamber. Steam passes upward through them, while the water spills down from tier to tier, constantly being exposed to the steam until, fully deaerated, it reaches the reservoir at the bottom.

The highest temperature incoming steam contacts this final deaerated water. It is also the purest, oxygen-free steam, and as it sweeps upward it takes to the vent all the freed corrosive gases.

The highly efficient internal vent condenser saves B.T.U.'s by reducing vented steam to a negligible wisp which is just enough to carry off all the non-condensable gases.

Guaranteed Water

These and the other design aspects of the Permutit Tray Deaerator enable us to give you a *guarantee* that you'll always get feedwater with (a) less than .005 ml of oxygen per liter of water, and (b) no titratable free CO_2.

And just off the presses is our Bulletin 4732, containing information on the construction details, operation, and other advantages of the Permutit Tray Deaerator. Send for a copy.

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to states and counties exceeded $6.3 million, an increase of seven per cent over the preceding year. In addition, the distributors of TVA power paid state and local taxes and tax equivalents of more than $10 million.

TVA's investment in electric plant reached $1.9 billion. Construction expenditures during 1960 totaled $103.3 million and are expected to increase to $166 million during fiscal 1961.

At the close of the year, generating capacity in service totaled 11,373,460 kilowatts, two-thirds steam and one-third hydro. Another 3,143,200 kilowatts was under construction. Among the projects under construction is a new steam plant near the village of Paradise on the Green River in Kentucky, where two 650,000-kw generating units are being installed.

Residential sales by the local distributors were 15 per cent higher in 1960 than in 1959, a rate of growth somewhat more rapid than usual. Average use by the residential consumers of TVA power was 8806 kilowatt-hours more than double the national average; the average residential rate was 0.99 cent a kilowatt-hour, about 40 per cent of the national average. More than 265,000 homes in the area now use electric heat, and the number is growing every year.

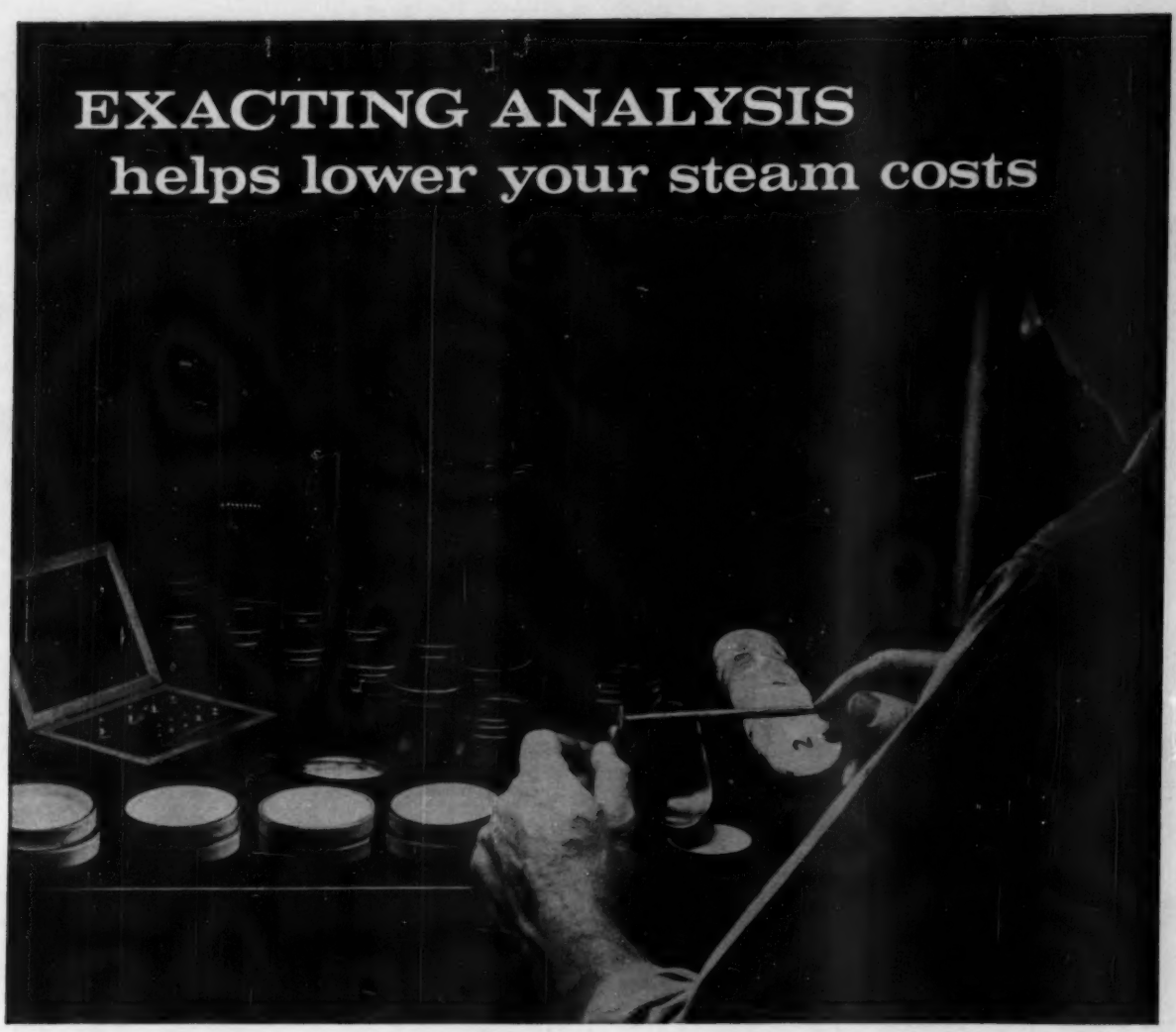
» **Construction authorizations** for natural gas pipelines reached a record high in the fiscal year ended June 30, 1960. Estimated cost of the new interstate natural gas transmission facilities is $846,677,000. Nearly 9400 miles of pipeline are included.

Both cost and mileage are record annual highs for the 18-year period that the Commission has had jurisdiction over interstate pipeline construction. In addition, certificates were issued authorizing approximately 403,000 horsepower in compressor units. New facilities will add more than 3¼ billion cubic feet daily to delivery capacity of the nation's transmission systems.

Since February 7, 1942, when the present certificate provisions of the Natural Gas Act became effective, the FPC has authorized construction of more than 94,000 miles of pipelines, over 6,438,000 horsepower in compressor units, and other related facilities with a total estimated cost of approximately $8,058,000,000.

Major projects authorized during this period were designed to add nearly 37 billion cubic feet of daily delivery and supply capacity to the individual systems involved. Total gas delivered directly from transmission facilities to the nation's markets is actually somewhat lower.

EXACTING ANALYSIS
helps lower your steam costs



An integral part in the preparation of Valley Camp Quality Coals is an exacting analysis for ash, moisture, and other undesirable materials. This constant quality control helps us to prepare coals with a high degree of uniform heat content, resulting in lowered steam costs for many plants.

Ask our combustion engineering service to show how such analysis can pay off in lowered steam costs for you.

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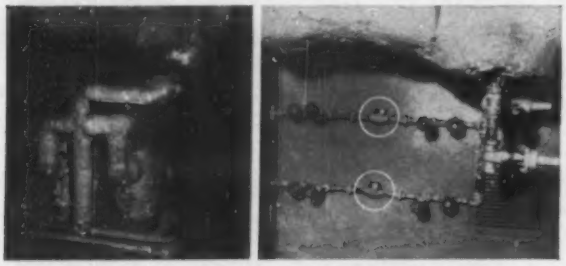
SARCO TOPICS

How major New York office building solved steam trapping problems through trap standardization

Recently, the Office Building at 625 Madison Avenue, New York, — erected in 1931 and comprising 420,000 square feet on 17 floors — discontinued its own steam generation and switched to district steam. The changeover made the inadequacies of old bucket and float traps more apparent than ever, and afforded an occasion to modernize trapping. Here's how major improvements were made.

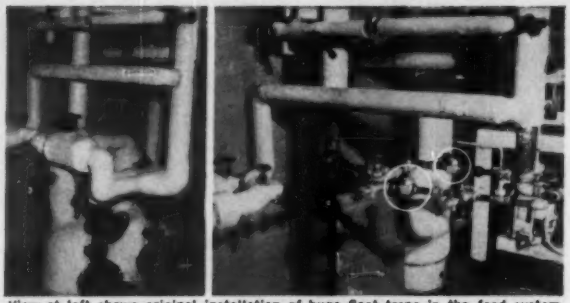
The first problem was maintenance. All maintenance had to be done at night or on weekends, at overtime rates, because the system could not be shut down during business hours. Frequent breakdowns added to maintenance costs. After the installation of Sarco Thermo-Dynamic Steam Traps, Type TD-50, trap maintenance — and therefore maintenance costs — have been reduced almost to zero. The engine room crew are now free for other jobs, and savings in both regular and overtime manhours are considerable.



Left picture shows the steam service main from the street, with massive float trap installation. Picture at the right is view of installation after the changeover to TD-50's (circled).

The second problem was water-hammer, caused by passage of live steam into return lines when traps failed open. (When traps failed closed, water accumulated in steam supply mains and equipment.) Installation of TD-50 steam traps ended waterhammer and consequent damage to equipment, because the TD-50 discharges condensate as rapidly as it is formed and prevents steam from entering the return system.

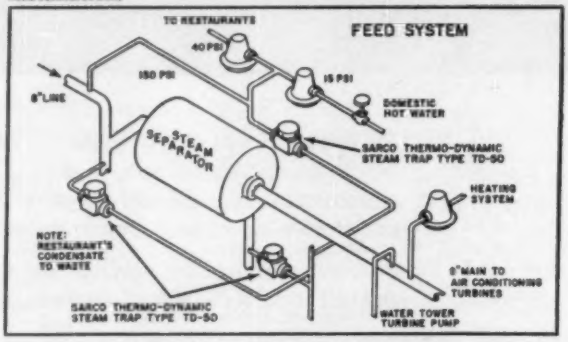
The third problem was live steam loss. Live steam, discharged into the return lines, not only represented a great waste of heat energy, but caused waterhammer in the return, and raised the condensate temperature to an excessive level. (Incidentally, although the building's district steam system is, of course, not faced with this problem, hot condensate passing through condensate pumps can damage pump seals.) These problems are eliminated through the use of TD-50's. No steam can be blown into the return main because the TD-50 shuts off *positively*, blocking any possibility of live steam being discharged into the return. Savings are considerable.



View at left shows original installation of huge float traps in the feed system of the building. View at the right shows compact installation of Sarco TD-50 Steam Traps (circled).

These benefits were achieved by replacing bucket and float traps with Sarco Thermo-Dynamic Steam Traps, Type TD-50, matched and correctly sized to the application. For example, many ½" bucket traps were replaced with ⅜" TD-50's, which have ample capacity for the job.

The TD-50's pressure range of 10-600 psi made it possible to standardize on one steam trap for a variety of applications that formerly required traps of many different types and pressure ratings. Finally, changeover took only 30 minutes per trap for each compact TD-50 installation.



Schematic hook-up of the converted feed system.

The success of this TD-50 installation led Collins, Tuttle Co., Inc., managers of the building, to substitute Sarco Thermo-Dynamic Steam Traps for competitive bucket traps in two other major New York buildings.

For more information on Sarco Thermo-Dynamic Steam Traps, contact your Sarco Sales Representative or district office, or write.

2165

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Maintenance Time: 40 Seconds. If it now takes your maintenance crew more than a couple of minutes to service an ordinary trap, you're throwing away valuable time. This Sarco Thermo-Dynamic can be cleaned, blown out if necessary, and reassembled on the line in as little as 40 seconds.

For Prompt Information on the TD-50 . . . or for fast help on the efficient solution of any steam trapping problems, get in touch with a SARCO District Office, Sales Representative, or Distributor. (There's one near you.)

Only SARCO makes all 5 types:

Thermo-Dynamic* • Thermostatic • Liquid Expansion • Float Thermostatic • Inverted Bucket

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PLANT: BETHLEHEM, PA.

Frequency for Recorders

Continued from page 67

problems were the capacitors in the frequency transducer and the first stage transistor. Although mica dielectric capacitors would be ideal technically, their high cost was prohibitive in the large capacities required. Polystyrene dielectric was the final choice and proved to be well chosen. The final transistor choice for the first stage was a germanium alloy junction type. These transistors were of the pre-aged type available from some manufacturers.

Excerpts from records of a 1000-hr time run are shown in Fig. 8. The average frequency between the marked points was determined by making comparisons of the indicated elapsed time of a synchronous clock operating from the generator set with the elapsed time from the U. S. Government station WWV time signal furnished by a local radio station. Average frequency is equal to:

$$60 + \frac{\text{(clock elapsed time — WWV elapsed time) in sec}}{60 \times \text{WWV elapsed time in hours}}$$

Not shown in Fig. 8 is the relatively large frequency drift during the warmup period, but it is trifling for this application. The accuracy of this system was as follows: After 1000 hr, drift was less than $\frac{1}{10}$ of 1 per cent, or 0.06 cps. THE END

District Heating

Continued from page 74

of throttling loss, though the loss is more hidden than in the case of a pure back-pressure turbine. Therefore, the design engineer is not released from the painful duty of predicting the load conditions by simply applying extraction-condensing heating units. On the contrary, one more unknown enters the picture when compared with the back-pressure turbine: the electric power demand.

Throttling losses described above might reach significant proportions, but one favorable fact should not be overlooked: a diminishing amount of steam only can be charged with the increasing throttling loss. When the throttling loss of the condensing steam is large, the amount of condensing steam is insignificant; and similarly the heating steam is throttled only when the heat demand drops. Magnitude of the losses is always insignificant compared with the savings derived from by-product power generation.

In the concluding article on central heating, Mr. Reti describes some particular applications and points out the many benefits to be derived from combined systems. Watch for it in a future issue. THE END

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REFERENCE FILE OF

Commercial Literature

Power Engineering

Reviewed here are the editors' choice of manufacturers' catalogs now available . . . selected on the basis of information helpful to power engineers. Use the Reader Service Cards to order free copies of those you would like to have in your own files

Insulation, Refractories

201 Thermal Insulation — Described in 54-pp Catalog IN-244A are Johns-Manville thermal insulations for all types of commercial and industrial requirements from −400 to 3000 F. Contains six sections, each devoted to a specialized group of insulations, including industrial and high-temperature; plumbing, heating and air conditioning; refrigeration; insulating firebrick and refractories; finishes and weatherproofing materials; also asbestos papers, millboard, felts, blankets.

202 Insulation Specifications — In this set of six specifications, Pittsburgh Corning Corp. covers applications of Foamglas insulation for industrial equipment and piping. Each booklet contains tables of suggested thicknesses of insulation to be applied, drawings of insulation procedure, supports and recommended finishes. Booklets are devoted to low-, medium-, high-, and dual-temperature equipment, to underground piping, and spheres.

203 Insulating Materials — Properties and specifications of over 30 insulations for service from sub-zero to 1900 F are presented in this 24-pp 1960 catalog of Baldwin-Ehret-Hill, Inc. Spun mineral wool, calcium silicate, and 85 per cent magnesia products in block, blanket, felt, fill cement, and pipe insulation are described. Thermal conductivities and tables of recommended thicknesses are given. A selection chart indicates temperature ranges of all included materials.

204 Insulation Specifications — Johns-Manville's 50-pp manual of specifications, IN-128A, is designed for power, chemical and petroleum industries. It is divided into five sections — insulations for temperatures above 100 F; those for temperatures below 100 F; tank insulation; sphere and spheroid insulation; regenerator, catalytic reactor and oil heater lining and insulation. Tables include recommended thicknesses for both steam generating plants and process equipment based on average economic conditions.

205 Thermal Insulation — This 16-pp bulletin released by National Insulation Manufacturers Association is designed to serve as a guide to best use of thermal insulating materials under changing conditions of modern industry. Emphasizes "economic thickness" approach to specification, which enables determining point at which insulation gives greatest financial return for its cost.

206 For Insulation Protection — Comprehensive data on mastics, coatings, adhesives, and flashing compounds for thermal insulation has been classified as to industry usage — power, process, cold storage, marine and commercial — in this ready-reference loose-leaf manual, about 208-pp, of Benjamin Foster Co. Detailed application information and product data included, as well as illustrations of uses.

207 Pipe-Fitting Insulation — Design features and advantages of an improved molded Fiberglas pipe fitting insulation are detailed by Fibrous Glass Products, Inc. in Bulletin TD-105. Specifications included.

208 Underground Piping Insulation — Advantages and characteristics of a granular insulation for underground steam lines, are detailed by Insul-Fil Co., Inc. in eight data sheets. Application details are illustrated and described and complete specifications included, as well as engineering drawings and graphs.

209 Refractory Cement — Heavy duty brick bonding and patching mortar is described in this 8-pp folder of Refractory and Insulation Corp. Includes success stories concerning the product's application in high temperature work and in the protection of equipment against slag, fly ash and gases.

210 Refractory Mortar — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant refinery and metalworking equipment offered by Universal Atlas Cement Div., United States Steel Corp. Includes data on mortar preparation, placing procedures, curing; also information on use of Lumnite cement as a masonry mortar for brick.

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Electrical Equipment

211 Synchronous Motors — Advantages of The Ideal Electric & Mfg. Co.'s high speed synchronous motors are detailed in 12-pp Bulletin 501. Cutaway view illustrates component parts and details of maintenance and operation. Applications and specifications data included.

212 Shielded A-C Motors — Comprehensive 56-pp Catalog 200, Sterling Electric Motors, Inc., includes complete dimensional, selection and application data on Multi-Shielded a-c motors. Includes information for various modifications, such as specialized mountings.

213 FHP Motors — Twelve-pp Bulletin GEA-6424A discusses features and advantages of General Electric Co.'s fractional horsepower, Form G, general purpose motors, including capacitor-start, split-phase, permanent-split capacitor, shaded-pole and polyphase motors. Sixteen different kinds of fhp motors are shown.

214 Submersible Pump Motors — Eight-pp Bulletin F-2000, U. S. Electrical Motors Inc. contains full-length cutaway drawings showing construction details, features of submersible motors for 6-, 10- and 14-in. well diameters and explains their water-filled operating principle. Also presents exploded and assembled views of the motors' thrust bearing.

215 Induction Motor Selector — Selection, application and buying information on General Electric Co's Tri-Clad '55 motors, single- and three-phase, from ¾ to 150 hp is given in 14-pp Bulletin GEC-1049. Includes basic information for motor users, application chart for various loads and ambient conditions, tables for dimensions, prices, characteristics and performance data, ordering instructions, modifications, and accessories.

216 Motor Application Guide — Sixteen-pp Bulletin 270B outlines characteristics of Century Electric Co. motors of 1/20 to 400 hp and includes up-to-date design information on them. Discusses factors in motor selection and provides illustrated charts covering a wide range of motor-using equipment. Also presented are gearmotors, selective speed drives.

217 Wire and Cable Data — These composite, color-coded data sheets contain information formerly found only in many catalogs on wires, cables and power cords. Prepared by Continental Copper & Steel Industries, Inc., data sheets give prices, stranding, strand diameters, temperature ratings, weights, overall diameters.

218 Portable Cords, Cables — Specifications and characteristics of various portable cords and cables are presented in this 52-pp booklet of Kaiser Aluminum & Chemical Sales, Inc. Gives pertinent data on insulation and jacket compounds, and includes tables giving properties of 600-v portable cables, from single to four conductor, also single- to four-conductor 601-5000v portable cables, and others. A section is devoted to splicing and patching.

219 Cable Splicing Fundamentals — Illustrated with step-by-step photos, this 30-pp booklet of The Okonite Co. explains procedure for splicing and terminating rubber-Neoprene cables, shielded and unshielded. Also includes tape selector and quantity estimating charts, product information and a purchase planning aid sheet.

220 Rigid PVC Conduit — Applications of rigid polyvinyl chloride in the electrical field are detailed in this 20-pp bulletin released by Kraloy Plastic Pipe Co., Inc. Included are comprehensive test results, specification information, installation instructions, corrosion-resistance charts, and other data.

221 Why Plastic Conduit — Advantages of using plastic conduit in a variety of electrical applications are detailed in this 6-pp bulletin of Southwestern Plastic Pipe Co. Mechanical, physical and electrical properties and other data are tabulated and installation discussed.

222 General Purpose Controls — Catalog 1260D, 72 pp, contains information on general purpose control devices available from General Electric Co. Charts are listed for motors from ¼ through 200 hp, affording quick selection of heaters and push button stations Product descriptions are provided for both manual and magnetic motor starters, relays, solenoids, limit switches, push buttons, static control and pilot devices. Pricing tables are included, also information on features, wiring, dimensions.

223 Voltage Regulators — Distribution voltage regulator features designed to provide more economical and better voltage regulation are described by Allis-Chalmers Mfg. Co. in 16-pp Bulletin 21B7977E. Describes unit construction, electrical re-settable position indicator, quick-break mechanism, optimum system size, oil sight gage, locked control knobs, external by-pass arrester, operation counter, bearingless voltage regulating relay.

224 Electric Motor Controls — Contained in 72-pp Catalog 5900 of Furnas Electric Co. are selector charts for magnetic and manual starters, giving horsepower, motor speed, heater size, heater ampere ratings, enclosure choices, along with style numbers and list prices. Covers manual starters, magnetic controls, drum controllers, pressure switches, various pilot devices.

225 Reduced Voltage Starter — Eight-pp Bulletin GEA-6860, General Electric Co. defines reduced voltage starters, tells when and where to use them and how to select them. Contains starter selection table and comparison table. Illustrations show the manual autotransformer, magnetic autotransformer, primary resistor, and part winding starters, and schematic connection diagrams are included for each.

226 Circuit Breaker Accessories — Twelve-pp Bulletin GEA6757 describes General Electric Co.'s industrial molded case circuit breaker accessories and modifications for a variety of control applications. Includes detailed selection data, outline dimensional drawings.

227 Rotary Handle Breakers — Eight-pp Bulletin 1425 introduces rotary handle circuit breakers of Federal Pacific Electric Co. and discusses their use in switchboards, control centers, panelboards and enclosed circuit breakers. Describes features of the handle mechanism — built-in construction, effortless operation, locking provision etc. Amply illustrated, bulletin also covers application of the 15- through 800-amp breakers.

228 Circuit Breakers — Low voltage stored-energy power circuit breakers are discussed by General Electric Co. in a 20-pp Bulletin GEA-5915E. Includes photographs, diagrams, graphs, charts showing specifications, operating features, dimensions, ratings for low voltage power circuit breakers and applications. Manual and electrical stored-energy closing mechanisms are described in a range of ratings through 600 v, 4000 amp.

229 Load Centers — Twin circuit breaker load centers designed to double the circuit capacity of load centers are featured by General Electric Co. in 16-pp Bulletin GEA-7071. Cutaway view showing component features is included, as well as tips on installation, selection data.

To order catalogs, use the Reader Service Post Cards

230 Unit Substations — Comprehensive Workbook PSG-6001, 24-pp, aids in planning articulated unit substations for secondary distribution, and features a suggested specification form detailing data for a properly coordinated substation system. Ratings, weights and dimensions are included. Types of load centers and substations are described for indoor and outdoor use. Detailed specifications are provided by Pennsylvania Transformer Div., McGraw-Edison Co., for incoming supply sections, transformer sections and outgoing feeder assemblies.

231 Unit Substations — Detailed information on features, operations and application of selectively-coordinated load center unit substations providing continuous power for a-c distribution systems is presented in 32-pp Bulletin GEA-3592L of General Electric Co. Compares types of load center arrangements and explains how selective coordination of load centers can be provided on any of four basic industrial and commercial building power distribution circuits. Includes photos, line system and schematic diagrams.

232 Electrical Distribution — Comprehensive information on electrical distribution products is presented in this 60-pp catalog of I-T-E Circuit Breaker Co. Divided into three main sections covering molded case circuit breakers, individually-enclosed low-voltage power circuit breakers, and engineered products, it contains selection and application data, selection charts listing types, ratings and accessories.

233 Electrical Distribution, Control — Complete with photos, tables of specifications, pricing information, wiring diagrams, this 155-pp reference catalog of Federal Pacific Electric Co. covers 30 types of products. They include circuit breaker load centers, fusible service equipment, enclosed safety switches, low voltage fuses, molded case circuit breakers, enclosed industrial breakers, wall mounted air breakers, bolted pressure contact switches, lighting and distribution panelboards, distribution switchboards, package power centers, wireways, bus duct, manual starters, others. Book is available to qualified power engineers.

234 L-V Distribution Equipment — General Electric Co.'s 84-pp, 1960 Buy Log covers log-voltage distribution equipment. It serves as a condensed buying catalog for service entrance equipment, light and heavy duty safety switches, tumble and open-knife switches, hinged wireway, circuit breakers, switchboards, motor control centers, sectional distribution centers, panelboards and busway. Among features provided are selector charts, pictorial descriptions, consolidated pricing tables.

235 Overload Fault Currents — Sixteen-pp Section 7 of an aluminum conductor engineering data series offered by Aluminum Co. of America, discusses overload and fault current limitations of bare aluminum conductors. Includes description of fault and overload currents, along with graphs showing maximum allowable time for various high value emergency or short circuit currents.

236 Industrial Capacitors — Twelve-pp Booklet B-7642, Westinghouse Electric Corp., answers questions concerning use of capacitors to reduce power costs, increase system capacity, and apply to industry. Subjects include: discussion of power factor, benefits of capacitors, how to select capacitors, and where and how to apply them.

237 Interrupting Capacity Chart — This chart, prepared by Westinghouse Electric Corp., aids in selecting and ordering proper circuit breaker for each application. In addition to interrupting ratings, chart tables of available fault currents are included.

238 Protective Equipment Guide — Form SPD is a 24-pp handbook on selection of protective devices for electric circuits, motors, appliances and apparatus. Prepared by Bussmann Mfg. Co. and based on 1959 National Electrical Code, it provides suggestions on how to select right kind of protection equipment, wiring diagrams and motor tables.

239 Electric Utility Instruments — General Electric Co.'s Bulletin GEZ-2975 contains 12 pp of information on instruments for generating plants, distribution areas, load-dispatching offices, substations, and electrical testing. Contains selection data on units for specific applications.

240 Testing Instruments — Twelve-pp Bulletin 19-60 contains descriptive information on industrial instruments available from James G. Biddle Co. They include electrical resistance testers, dielectric test sets, cable fault locating equipment, turn ratio test sets, and others. Advantages are detailed.

241 Portable Test Units — Presented in this 48-pp booklet of Multi-amp Electronic Corp. is detailed information on portable test units for protective relays. Subjects treated include classification of relay tests; preparation for protective relay testing; reasons for an adequate testing and maintenance program; tips on tester selection. How the test units can aid in relay functioning is discussed.

242 Silicon Rectifiers — Booklet B-7900, which tells why silicon rectifier packages offer d-c power saving to the electrochemical and allied industries, is offered by Westinghouse Electric Corp. This 20-pp publication presents detailed description of a silicon power package and states the advantages of silicon over other rectifying methods.

243 Insulation Materials — Illustrated 36-pp Catalog 34 presents electrical insulation for repair and maintenance of motors, generators, and electrical or electronic equipment. Prepared by Insulation Manufacturers Corp. covers packaged insulation products: cotton, asbestos, and woven glass tapes; cotton, glass and varnished or saturated tubing and sleeving; mica plates and laminates: varnished fabrics; insulation papers; high temperature insulation materials for Class H units; baking and impregnating varnishes; pressure sensitive tapes.

244 Electrical Insulation — Twelve-pp Bulletin GET-2929A describes in text, tables and illustrations the characteristics and applications of General Electric Co.'s insulating materials for electrical equipment. Provides technical data and suggested uses of such products as mica mat, built-up mica, coated materials, varnishes, paints, adhesives, compounds, thinners, irradiated materials, others.

245 Electrical-Insulating Varnish — This 36-pp catalog of Minnesota Mining & Mfg. Co. covers selection and application of electrical insulating varnishes with complete details on all electrical and mechanical properties as well as operating temperature limitations. Includes charts, graphs and illustrations on temperature conversion, solvents, specific gravity, viscosity.

246 Printing Demand Meters — General Electric Co.'s Bulletin GEA-6892, 8-pp, describes printing demand meters for precision recording of loads. Discusses application, design, and cost of PD-55F and PD-57F meters. Also includes operating, construction and electrical specifications, and dimension diagrams of units.

247 Battery Technology — Bulletin GB-1896 is a 36-pp handbook of technical instructions and engineering data on the care of motive power storage batteries offered by Gould-National Batteries, Inc. It covers all phases of lead acid battery theory, operation and maintenance. Captioned line drawings are included as well as changes, charging and discharging cycles, plate composition.

248 Battery Chargers — Selenium or silicon rectifier battery chargers designed for station-type batteries used by utilities and industrial plants are described in this product bulletin of Syntron Co. Specifications, data and descriptions of standard models ranging from 15- to 200-amp capacity included.

These catalogs can be yours without cost or obligation. Use the Reader Service Cards to indicate your choice—just circle the item numbers of those you want

249 Tungar Bulb Data — Eight-pp Publication ETR-2091, a revised edition of General Electric Co.'s manual on Tungar bulbs, contains typical circuits and operating data. Also provides descriptive and theoretical data on use of Tungar bulbs in rectifier circuits to provide noise-free power supplies with low voltage drop and high efficiency.

250 Commutator Maintenance — This commutator and slip ring maintenance data file of Ideal Industries, Inc. contains information on methods and procedures for more efficient commutation. Individual bulletins cover brushes, sparking, picking, dragging and other troubles, maintenance tools and how to use them.

Postage-free Reader Service Cards are on pages 109-110

251 Electrical Equipment Guide — Describing heavy duty electrical transmission and distribution equipment for commercial, industrial and other installations, this catalog digest of Continental Electric Equipment Co. contains detailed specifications. Presents interrupter, switches, medium voltage switchboards, unit substations, power centers, low voltage switchgear, panel type switchgear, bus ducts, bus plugs, motor control centers, panelboards, circuit breakers, safety switches, instrument and control boards. An "easy price estimator" is included. Available to qualified power engineers, please state your job title.

252 Terminal Boxes — Bulletin 28 describes weatherproof multi-junction terminal boxes with cellular neoprene gasketed covers available from Thermo Electric Co., Inc. Lists dimensions and capacities, and includes specifications and engineering drawings showing arrangement of terminal strips.

253 Channel Fittings, Hangers — This pocket-size reference type work manual, about 68 pp, contains product illustrations and correlated information for specifying and using structural support materials for electrical installations. A publication of Steel City Electric Co., it is indexed to sections identified with specific areas of applications . . . as for suspending single and multiple runs of conduits; building racks and frames; concrete inserts; beam clamps for fastening to structures; brackets and supports; fluorescent fixture supports. Tables show strength of sectional units, deflections and load bearing capacities.

Catalogs reviewed here are offered primarily for qualified power engineers. Manufacturers may withhold literature from persons who do not state their job title and company. Some manufacturers also prefer not to send literature to those in foreign countries in which they have no sales representative.

254 Low-Voltage Switching — Twenty-pp Electrician's Manual RM-610 offered by Remcon Div., Pyramid Instrument Corp., contains an introduction to low-voltage switching. Explains how company's remote-control switching works electrically, how components are mounted, how to plan a layout, and gives installation instructions.

255 Power Supply Handbook — Tabular specification data on regulated d-c supplies, frequency changers (variable frequency power sources) high-voltage power supplies (to 600 kv) and other high-voltage products, miniature transistorized power supplies, inverters and converters, and a-c line-voltage regulators are presented by Sorensen & Co., Inc. in this 32-pp power supply handbook.

Lighting

256 Floodlight Data in Brief — Pocket-sized Bulletin 2714 is a 184-pp miniature edition of Crouse-Hinds Co.'s floodlight catalog, and includes all original material. Covers selection of floodlights, general purpose floodlights, heavy duty models, mercury vapor floodlights, special types, lighting for hazardous locations, searchlights, poles, accessories. Includes installation suggestions and lighting calculations.

257 On Floodlighting—Bulletin GEA-7201, 10-pp, stresses value of good floodlighting, and gives application data and product information on filament, mercury vapor and fluorescent units. Photos show typical applications in recreation area, architectural and ornamental lighting, loading platforms and industrial areas. A publication of General Electric Co., also tells how to get more light per dollar.

258 Aluminum Floodlights — Catalog S, 8-pp, gives condensed data on cast aluminum outdoor floodlights of Stonco Electric Products Co. Covers new decorative outdoor bullets, medium and mogul base floodlights, high intensity Power-Beams, emergency portables, wiring troughs splice boxes, outdoor fittings, and fixtures designed for vaportight service.

259 Area Floodlighting — Planning for lighting of parking areas and other open areas is detailed by Crouse-Hinds Co. in 16-pp Bulletin 2719. Contains reference guides for selecting incandescent or mercury floodlights, general purpose or heavy duty types, and for determining how many floodlights are needed based on size of area, as well as footcandle charts, installation diagrams.

260 Incandescent Lighting — The 24-pp "Incandescent Lighting Guide Book" of Sylvania Electric Products Inc., features sections on the general advantages of incandescent lighting, the history of incandescent lamp developments, and includes chapter on basic types, bulb shapes, sizes, glass types and finishes, and bases.

261 Group Relamping Plan — Eight-pp Booklet A-6832 describes a group relamping plan designed by Westinghouse Electric Corp. to reduce costs, provide better lighting, and cause fewer work interruptions. Sample calculations provide data for setting up a schedule.

262 Lighting Maintenance Tips — Principles and advantages of good lighting practice are presented in Champion Lamp Works' 48-pp lighting maintenance manual. Includes guide to trouble shooting fluorescent installations, a section on planning group replacement of lamps, and cleaning.

263 Vapor-Tight Fixtures — Presented in this 52-pp catalog supplement of Killark Electric Mfg. Co. are vapor-tight aluminum lighting fixtures. They include pendant, ceiling and bracket types for a variety of installations. Reflector styles — shallow bowl, standard dome or angle — are also described, and information on accessories available.

264 Lighting Specifications — Included in the 52-pp 1960 edition of the RLM Standard Specifications, are three new specifications for 1500 ma units: D-4 fluorescent semi-direct medium high mounting, SD-3AL semi-direct aluminum, and SD-3PE semi-direct porcelain enamel units. The book contains many upward revisions of existing specifications, and new specifications for aluminum reflectors and added provisions for inspection. Booklet is prepared by The RLM Standards Institute, Inc.

265 Modern Lighting Needs — "Footcandles in Modern Lighting," is General Electric Co.'s 20-pp revised booklet giving lighting level recommendations for seeing tasks involved in hundreds of industrial and other activities. Figures are based on findings of Illuminating Engineering Research Institute and Illuminating Engineering Society. Also discussed are other aspects of lighting to be considered in making practical decisions about lighting levels.

266 Lamp Ballast Service — Described by Universal Mfg. Corp. in this product bulletin is a service program for fluorescent lamp ballasts which provides immediate replacement of inoperative ballasts Also described is a 24-hr engineering service for design consultation, installation assistance or trouble-shooting.

267 Miniature Lamp Data — This 24-pp pocket size booklet of Chicago Miniature Lamp Works lists standard miniature lamps now available, and the sources of supply from which they may be obtained. Specifications of the lamps (nearly 400) are given as well as lamp nomenclature with drawings of styles.

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Ventilating, Refrigeration and Air Conditioning

268 Industrial Fans — Fundamental data relating to capacities and construction of industrial fans incorporating a universal discharge are presented by Lehigh Fan & Blower Div. of Fuller Co. in 28-pp Bulletin L-5. Included are rating tables giving volumes of air delivered, rpm, horsepower at various static pressures, and outlet velocity and velocity pressures, as well as tables of correction ratios for deviations from the standard atmospheric conditions.

269 Propeller Fans — Included in 20-pp Bulletin A-109 E of Hartzell Propeller Fan Co. is new line of low-speed high volume fans designed to increase efficiency and economy where large volumes of air must be moved, because a single unit does the work of several smaller ones. The line covers sizes from 65 to 94 in., in belt-, direct- or pulley drive. Other fans cataloged are ring and panel mounted types from 12 to 60 in., low noise and high pressure models, a reversible fan, and pedestal and spot cooling types.

270 Centrifugal Fans — Catalog 1120-1 of Westinghouse Electric Corp. contains 76 pp of detailed information on all-purpose centrifugal fans with flat, backwardly inclined blading, suited for supply and exhaust, general building ventilation, industrial air conditioning and processes. Key components and features are illustrated, and tabular performance data included.

271 Air Engineering — Bulletin E-57, is a 24-pp air engineering data file, offered by Aerovent Fan Co., Inc. Covers engineering and test facilities for propeller fans, specifications, construction, maintenance, and installation. Tables for estimating air-handing requirements, entrance and elbow losses provided.

272 For Controlled Ventilation — This 20-pp catalog of The Loren Cook Co. is designed as a guide in determining exact type ventilation equipment for specific needs. Guide matches design features with ventilation requirements and special conditions, controlling efficiency, and economy and lengthening life of unit. Includes performance and dimension charts.

273 Plastic Ventilating Equipment — Illustrated and described in 18-pp Bulletin B-500 are plastic ventilation products of Heil Process Equipment Corp. including ventilating ducts, fittings, exhaust hoods, stacks, covers, fans, and fume scrubbers. Physical and chemical properties of glass-reinforced plastics given.

274 Conditioner Units — Design features of Climate Makers, based on the building block principle, are detailed by Airfan Engineering Co. in 60-pp Catalog AHV-59. Engineering information provided includes fan capacities, direct expansion cooling capacities, and coil data, chilled water cooling capacities, chilled water coil data, mean effective temperature, psychometric data, steam and hot water heating capacities.

275 Cold Room Conditioning — In Bulletin 95, Niagara Blower Co. describes the No-Frost method of producing temperatures down to −90 F for freezing, testing, cold storage etc., giving advantages. Operation with two-stage and three-stage cooler discussed.

276 Refrigeration Condensers — Engineering data on a complete range of sizes and types of refrigeration condensers are featured by Henry Vogt Machine Co. in 38-pp Bulletin RC-2. Ratings in tons refrigeration are tabulated for large and small ammonia condensers, vertical ammonia condensers, ammonia condenser-towers, freon condensers and freon condenser-towers.

277 Coil Selection Guide — Information on Young Radiator Co.'s water and direct expansion refrigerant coils is given in 28-pp Catalog 5559. Provides selection data on water heating and cooling coils; physical and performance charts; mean effective temperature difference charts. Explains determination of final dry bulb temperature and direct expansion coil surface temperatures. Also includes capacity tables, psychrometric chart, total heat table, dimensions, piping diagrams.

278 Zone Control Cabinets — Illustrated and described in 20-pp Bulletin AC-220 are Buffalo Forge Co.'s sectionalized easy-to-assemble units with separate fan section, coil section, zone dampers and optional accessories. Includes physical data, dimensions, fan performance tables, coil ratings, and selection data.

279 Refrigerated Purging Guide — In 12-pp Bulletin 700, Armstrong Machine Works gives helpful data on automatic removal of air from refrigeration systems. Tells why purging is necessary, how noncondensable gases affect efficiency, methods of purging, where to make purge connections and how to use the purger.

280 Air-Cooled Condensers — Four types of air-cooled condenser units are discussed by Halstead & Mitchell in 12-pp Bulletin AC-102 — those using propeller fans for horizontal air flow, propeller fans for vertical air flow, centrifugal fans for use with ductwork, and centrifugal fans. Coil and fan data are given as are capacities in Btu per hour at evaporator, also detailed specifications.

Lubrication

281 On Centralized Lubrication — Information on a centralized system of lubrication is presented by Farval Div., Easton Mfg. Co. in 24-pp Bulletin 26-T. Advantages and principles of operation are discussed, also system components. Typical applications illustrated.

282 Oilers and Containers — Detailed information on oilers, safety cans, and oil and gasoline containers is presented in 30-pp Condensed Catalog 60-C of Eagle Mfg. Co. Size and capacity data along with descriptive details and photos of oilers included.

283 Turbine Lubrication — Basic lubrication requirements for a wide range of turbines and gears are detailed by Murray Iron Works in Bulletin T-125-A. Sections cover care of the oiling system, turbine lubricants, lubricating oil recommendations, reductions gears and geared units. Oil circuit diagrams included.

284 Organized Lubrication — Benefits of organized lubrication are extolled by Texaco, Inc. in this 24-pp bulletin. Cost control opportunities are detailed, and task of assigning responsibilities in an organized lubrication system are discussed. Method of determining savings and setting up records to measure results covered.

285 Lubricant Data—Characteristics, advantages of specialized fluid and grease type lubricants are described in 32-pp Data Book 59-2, by Lubriplate Div., Fiske Bros. Refining Co. Includes sections on control of friction, use of grease type lubricants, proper applications, and recommendations for various operating conditions.

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Piping, Valves and Fittings

286 Valve Selection Tips — In addition to cross indexing company's own line of valves with those of other manufacturers, The Ohio Injector Co.'s Valve Buyer's Guide, 22 pp, contains a list of frequently used abbreviations, a valve trim chart, other data. A breakdown by valve material and pressure class, and classification by type, disc design, seating arrangement, stem operation, bonnet and end connection also aid in selection.

287 To Stop Water Waste — Bulletin 553-A of Leslie Co. points out ways that proper valve selection and application can reduce "hidden costs" connected with the use of water in industry. Describes how water reducing valves operate and gives information on sizing.

288 Valve Selection Data — Facts to keep in mind when selecting a valve for a specific application are detailed in Crane Co.'s 20-pp Bulletin AD-2016. Three principal valve types are illustrated and described, and cutaway views showing component features included.

289 Reducing Valves — Direct-operated water pressure reducing valves are featured in illustrated Bulletin 1009, Spence Engineering Co., Inc. A cutaway view showing component features is included, as well as water capacity table, dimensional tables and diagrams.

290 Electric Check Valve — Described by Golden-Anderson Valve Specialty Co. in 8-pp Bulletin W-10A is a double-cushioned electric check valve providing normal function with adjustable opening and closing speeds and fast emergency closing. Dimensional data, cross-sectional views and suggested wiring diagram included.

291 Check Valves — Details and specifications on check valves designed to eliminate water hammer and line surge are presented by Combination Pump Valve Co., in 20-pp Catalog 600. Typical installations are illustrated, and installation data, flow chart, and pressure-temperature ratings included.

292 Valve Materials Calculator — Preferred valve materials for different types of corrosives are shown in this calculator prepared by Hoke, Inc. It is designed as a guide to the selection of materials of valve construction ,based on "substantial", "moderate", "questionable" or "inadequate" resistance to the chemical in question at atmospheric pressure and temperature. Also lists control products for handling corrosive fluids.

293 Stock Solenoid Valves — Solenoid valves available "off the shelf" from Automatic Switch Co. are presented in 16-pp Stock List and Selection Guide 506. Contains engineering information, simple selection data, illustrations and flow diagram of two-, three- and four-way types, manual reset valves, special purpose valves and strainers. Prices are also provided.

294 Specifying Solenoid Valves — Included in Valcor Engineering Corp.'s 8-pp booklet on specifying solenoid valves are a description of various types of valve sealing; a discussion of mechanical specification criteria including application description, fluid characteristics, pressure, capacity, leakage, valve life, speed of operation, electrical and environmental specification criteria

295 Relief Valves — Bulletin V-100/60, 24-pp, describes J. E. Lonergan Co's. line of bellows valves for vapor service. It gives complete details and specifications on sizes, capacities, materials and other pertinent data. The seven exclusive features of this valve are also listed.

296 Safety-Relief Valves — Liquid relief and special service safety-relief valves, including a new, low cost compact series, are presented by Farris Engineering Corp. in 28-pp Catalog FE-138. Valves shown include types for hydraulic pressure systems, liquefied gases, chemical corrosive service and general industrial service. Sizing information, capacity tables, weights and dimensions, and application data are arranged in a new format which simplifies valve selection.

297 Solder Joint Valves — This Walworth Co's. circular lists in detail the size and dimensions of bronze gate, globe and check solder joint valves including the new No. 2 SJ gate valve. Each type is illustrated with a cutaway picture showing path of fluids through valve body. An illustrated set of instructions shows how to make a sound solder joint.

298 For Throttling Service — The Monoflange Mark II of Henry Pratt Co. is introduced in Bulletin 10-G, a 16-pp working guide on this rubber seat butterfly valve. In sizes to 20 in., this valve mounts between flanges and is designed to provide leak tight closure at 150 psi, maximum temperatures 200 F. Catalog gives full specifications, certified dimension drawings, water and gas flow data, weights and freight rates, prices. Also describes manual and automatic operators available.

299 Guide to Strainers — Presented by Tate Engineering, Inc. in this 88-pp handbook on strainers is a compilation of reference data for layout of fluid flow systems and sizing of strainers, tabulated results of testing, and valve and pipe selection information. Reference material for each strainer section is on a fold-out page for use with any specific page in that section. Book contains over 100 illustrations of pressure drop, temperature, and viscosity charts, also engineering drawings.

300 Supports for Piping — Described in 96-pp Catalog 59, is a system utilizing pre-engineered standard components in almost infinite combinations to solve most piping and equipment support problems. The system, introduced by Bergen Pipesupport Corp., affords savings in engineering and field costs, eliminates detailed hangar drawings and offers simplicity of use. Book also gives details on constant support hangers; roller devices; variable supports, light duty and cushion-spring hangers, sway braces; standard assembly parts and hardware, and hanger assemblies.

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301 Power Process Piping — Piping systems fabricated and erected by Midwest Piping Co., Inc., for power stations and industrial plants are highlighted in 24-pp Bulletin 60B. Includes case-history stories of over 30 plants. Also includes section on weld fittings and flanges.

302 Pipe Thread Fittings — Advantages of pipe thread fittings designed to eliminate positioning problems, leakage, and overtightening damage are detailed by the Tru-Seal Div. of Flick-Reedy Corp. in this product bulletin. Common types of positioning, distortion, alignment, reworking and leakage problems and their solutions are illustrated, and installation and dimensional data given.

303 Plastic Pipe, Fittings — PVC pipe, valves and fittings and their uses are covered in this 36-pp handbook by Kraloy Plastic Pipe Co., Inc. Specification, design and installation data are included, as well as a comprehensive corrosion resistance comparison chart of seven types of plastic pipe carrying 162 chemicals.

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304 **Good Piping Charted** — Recommended piping practices are presented in this wall chart form by The Lunkenheimer Co. Chart is divided into five sections covering basic valve types, connections normally used, installation and maintenance tools, installation, operation and maintenance. Illustrations of valves, engineering specialties and lubricating devices appear on back.

305 **Pipe Alignment Guide** — This bulletin of The Align-O-Pipe Guide Co. introduces a device for guiding pipe lines which are expanding or contracting because of temperature changes. Explains how units permit movement of pipe line in an axial direction only. Discusses necessity for pipe alignment guides, benefits afforded by them, how to use them.

Metals

306 **Steel Analysis** — In this 20-pp pocket-size booklet, Jones & Laughlin Corp. lists compositions of 40 stainless steels, 184 alloy steels and 105 carbon steels most often used in industry. It also contains federal specifications with corresponding SAE, AISI and AMS numbers.

307 **Steel Weight Tables** — This 72-pp booklet, released by Jos. Dyson & Sons, Inc., contains weight tables of steel, including weights of round, square, hexagon, octagon, and flat steel bars in a wide range of thicknesses. Also includes decimal equivalents, tables of area and circumferences of circles, and other formulas.

308 **Rugged Castings** — Properties and applications of heat and corrosion resistant castings are given in this 64-pp booklet of The International Nickel Co., Inc. Designed to aid in stainless steel and high-alloy casting selection, it offers comprehensive data on all types of stainless steel and high-alloy heat and corrosion-resistant castings and their applications.

309 **Ferrous Metallurgy** — "Basic Guide to Ferrous Metallurgy" is a four-color chart prepared by Tempil Corp. showing principal characteristics of steels (with carbon content ranging to 0.9 per cent) across the temperature range to 1900 F. Important working zones including preheating for welding, stress relieving, normalizing, annealing, carburizing and forging are shown.

310 **Using Specialty Steels?** — Offered by The Carpenter Steel Co., this 40 pp guide to selection of specialty steels contains information on tool and die steels; stainless steels; high temperature alloys; electronic; magnetic and electrical alloys; special purpose alloy steels: tubing and pipe, fine wire specialties. Includes tool steel selector chart providing a system of matching tool steels.

Pumps and Compressors

311 **Vertical Turbine Pump** — Featured by Worthington Corp. in 16-pp Bulletin 2400-B1 are ultra high flow vertical turbine pumps. Design improvements, which result in broader coverage and higher effiiciencies over wider operating ranges, are illustrated and described.

312 **Submersible Sump Pump** — Eight-pp Bulletin 5300, The Deming Co., describes features and operation of a submersible sump pump which can be lowered into a pit for temporary service or permanently installed for continuous service. Performance and dimension tables included.

313 **Metering Pumps** — Introduced by Wallace & Tiernan, Inc. in this 12-pp catalog is the Series 200 metering pump, an electrically driven pump of positive displacement, reciprocating, plunger type, capacities from 0.65 to 2025 gph. Design and operating features, possible arrangements and standard materials of construction are covered.

314 **Rotary Vacuum Pumps** — Features of Consolidated Vacuum Corp's oil sealed rotary vacuum pumps are detailed in 6-pp Bulletin 8-15. Discusses building block construction, ease of maintenance of these pumps, includes selection suggestions. Dimensions, physical specifications and data on speeds and capacities provided for single- and two-stage models.

315 **Rotary Air Pumps** — Catalog 460, 32 pp, of Leiman Bros., Inc., describes rotary positive air pressure and high vacuum pumps, gas boosters and air motors. Gives construction details, dimensions, capacities, performance curves for all pumps, plus comprehensive engineering and application data. Included are two- and four-vane types, single and double cylinder, fan-cooled, water-cooled, air-cooled, oilless, motor-driven, belt-driven, direct-coupled, automatically controlled and integral pump and motor models.

316 **Free-Piston Pumps** — Features and advantages of an air-operated free-piston pump designed to pump anything that flows are detailed by The Crossley Machine Co. in this product bulletin. Sequence diagrams showing operation included.

317 **Power Plant Pumps** — Bulletin BJP-588, Byron Jackson Pumps, Inc., describes standard pumps for all power plant requirements — from 12,000 hp, double-case boiler feed pump, to condensate, circulating and booster pumping duty. Also describes special pumps for nuclear power plant installation.

318 **Sizing Cooling Tower Pumps** — Six steps to be taken in sizing pump and piping of any cooling tower installation are explained by Bell & Gossett Co. in 6-pp Bulletin CT-360. Provides selection charts, pipe sizing tables and drawings of installations.

319 **Pumps, Proportioners** — Eight-pp Bulletin 600 describes Vari-Flow variable capacity rotary pumps of Blackmer Pump Co. These pumps are designed to let you "dial" desired flow rate, from zero to full capacity without changing pump speed. Explains principle of operation and includes cutaway illustrations of four basic models offered in ball-bearing or packing-gland types, sizes to 450 gpm.

320 **Chemical Feed Systems** — In Bulletin 558–3 Milton Roy Co. describes a line of controlled volume pumps and accessories for feeding water treatment chemicals. Design and construction features are detailed, and specifications given.

321 **Proportioning Pumps** — Details on proportioning pumps and package chemical feeding units for controlled capacity are presented in a product bulletin released by The Bird Archer Co. An application chart and detailed specifications are included

322 **Pumps and Controls** — Bulletin 220 contains 72 pp of data on design details and operating characteristics of hydraulic pumps, fluid motors and valves offered by Dennison Engineering Div., American Brake Shoe Co. Sections are devoted to types of hydraulic pumps, pumping units, fluid motors, and control valves, covering design and operating characteristics of components involved, with tables of performance data.

323 **For Abusive Pumping Jobs** — Catalog 5206, Nagle Pumps, covers centrifugal pumps adapted to handling ashes, abrasive mixtures, slurries, hot and corrosive liquids. It describes several basic types: a horizontal shaft, single-stage side suction pump; a horizontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft pumps with standard, overhead and quill bearings for wet pit applications.

324 **Simplified Pump Selection** — Technical data is simplified and presented in an easily-understood way in the Deming Co.'s rotary pump selection manual. Groups liquids according to viscosity and each classification has its own selection table. Fast selection is possible by matching liquid to pump. Selection tables cover most all liquids.

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325 Compressed Air Fundamentals — Sixteen-pp Form 1548, Ingersoll-Rand Co., is intended to aid in selection of a small "packaged" air compressor. Discusses compressed air, how it is compressed, single- and two-stage compressors, piston displacement, control used etc. Includes information on compressor oils, pipe sizes, wire sizes, terminology. Also provided is data on cubic feet of air required to operate a variety of pneumatic equipment.

326 On Eliminating Explosions — In 12-pp Bulletin 173, Clark Bros Co., presents recent findings on mechanism of explosions in pipelines and compressor starting air lines. Discusses research on nature of explosions and shock waves in piping, and these observations are applied to compressor air starting systems. Concludes with discussion of preventive measures for eliminating such explosions.

Dust Control

327 Dust Collection, Recovery — A series of product bulletins on Western Precipitation Corp.'s dust collection, precipitation and gas scrubbing equipment is provided in this literature folder. Equipment described includes electrical percipitators, mechanical dust collectors, gas scrubbers, high temperature dust collector, reverse-jet equipment, rapper control, fly ash collector, transistomatic precipitator control.

328 Dust Collectors — Included in 16-pp Bulletin 1828, American-Standard, is a list of typical industry dust control applications . . . for power plants, steel production, cement and aggregate production, chemical and petroleum processing, food and grain processing and general manufacturing. Covers operating characteristics, construction features, and includes nomogram presentations designed to simplify engineering calculations, assembly arrangements, line drawings.

Letters from readers are always welcomed by the editors—but the easiest way to get these catalogs is to use the Reader Service Cards provided

329 Electronic Air Cleaner — Twelve-pp Bulletin 405, Dollinger Corp., describes features and advantages of an electronic air cleaner based on the principle of electrostatic precipitation. Diagrams, photos and specifications are included.

330 Mechanical Dust Collectors — Recent improvements in mechanical dust collectors including a new involute design are described in 8-pp Bulletin 300 of Research-Cottrell, Inc. Contains detailed drawings and application diagrams.

Automation, Instruments and Controls

331 Automatic Controls — Comprehensive data on mercury-switch equipped controls for single-stage pressure, two-stage pressure, differential pressure, single-stage temperature, two-stage temperature, liquid level and mechanical movement are presented by The Mercoid Corp. in 56-pp Catalog 860. Each control with accompanying description, specifications and engineering data is indexed by product name and type number.

332 Telemetering Systems — Metameter telemeters for remote measurement, recording and automatic control are described in 52-pp Bulletin M1715 of The Bristol Co. Covers principles of operation, types; application to various factors including pressure, water level, temperature, flow, motion and position; and electrical quantities. Several applications in various industries and utilities are covered.

333 Metering Control Systems — Bailey Meter Co.'s Bulletin 500 describes purpose, design and operation of company's metering and control systems. Includes discussion and pneumatic control, along with detailed literature references.

334 Industrial Controls — This 88-pp catalog presents comprehensive information on controls, offered by General Controls Co., including automatic temperature, pressure, level and flow controls, as well as counters, switches and automation controls. Other items described are industrial actuators, combustion instrument controls, controller indicators and pressure indicators.

335 Temperature Controls — Filled with charts, drawings and diagrams, 24-pp Bulletin 101, of the Partlow Corp., discusses industrial temperature measurement and control, including ways of responding to temperature, ways of putting temperature response to work, mercury-bulb instrumentation, basic types of controls, and a score sheet for the mercury-bulb system. Also covers basic concepts of electrical, pneumatic and mechanical control instrumentation

336 On Thermocouples — Detailed information on thermocouples and thermocouple components and accessories is contained in 50-pp Catalog EN-82 of Leeds & Northrup Co. Lists and describes standard assemblies in protecting tubes and wells for general applications; specialized thermocouples and assemblies; and bare and insulated thermocouple wires, replacement elements, ceramic insulators, metal and ceramic protecting tubes, wells, terminal heads and extension leadwires.

337 How to Select Recorders — Buying information on recording instruments of General Electric Co. is provided in 12-pp Bulletin GEA-6933, including dimensions and chart speeds, operating specifications, applications, features and accessories. Recorders are grouped by accuracy class. Also described are specialized recording instruments — recording vibrometers, automatic oscillographs, self-balancing potentiometers.

338 Mass Flowmeter — Bulletin GEA-6925, 8-pp, describes theory, operation and advantages of General Electric Co.'s flowmeter that measures flow of fuels, industrial liquids, and gases directly in pounds. Includes ranges, specifications and dimensions, and drawings illustrating operation of the instrument.

339 Unit Ventilator Control — Described in this unit ventilator control application manual, about 88 pp, are Barber-Colman Co.'s automatic control systems for hot water, steam, gas-fired and electric unit ventilators. Control applications are shown on each page, covering makes and models marketed by major unit ventilator companies. Complete cycles of operation, damper sequence charts, specifications for precise temperature control and installation data included.

340 Leak Detector — Instructions on use of halogen leak detectors for finding leaks in enclosures that can be pressurized, in such applications as steam boilers, valves, piping, transformers, air-conditioning and refrigeration equipment are given by General Electric Co. in Bulletin GET-2936, 6 pp. Discusses system preparation, testing procedures, quantitative measurement techniques, and calibration.

341 Rotameters, Flow Indicators — Condensed Bulletin M-1 features Schutte and Koerting Co.'s instruments for measuring, indicating, recording and controlling rate of flow of all types of fluids. Various rotameters are described, also flow indicators for installation in pipe lines where it is necessary to see that fluid is flowing in right direction and in proper state and condition.

342 Test Instruments — Catalog G-10 contains 48 pp of detailed information on scientific measurement, recording, and testing instruments of Minneapolis-Honeywell Regulator Co. Among those covered are d-c amplifiers, data handling systems, calibration instruments, magnetic tape instrumentation, nuclear instrumentation, oscillographs, recorders and indicators, servo components, temperature controllers and transducers.

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343 Pressure Gages — Featured by J. E. Lonergan Co. in 46-pp Catalog 1000G are pressure indicating and vacuum gages for industrial, chemical, and refinery applications. Selector tables give data on various gages and recommended services. Specifications, standard graduation tables, photos, and dimensional diagrams included.

344 Hydrostatic Instruments — In this 88-pp pocket-size handbook of hydrostatic instrumentation, Petrometer Corp includes information on principles of hydrostatic measurement, selection and installation of instruments, design and construction of panel systems, as well as engineering data and diagrams. Provides tank volume formulae, conversion tables, viscosity charts, hydrometer scales, specific gravity tables for various liquids.

345 Air Meters — Catalog 170 describes air velocity, flow, pressure and vacuum measuring instruments operating on the compensated thermopile principle of Hastings-Raydist, Inc. Basic circuit of compensated thermopile shown.

346 Water Level Gages — Twelve-pp Bulletin WG-1815 describes Yarnall-Waring Co.'s color-port gages for medium boiler pressures to 1050 psi, and high pressures to 3000 psi. Details of gages, water columns, color-port inserts, and gage valves are given, with dimensions, data on transmittal of readings, servicing.

347 Water Columns, Gages — Featured by Reliance Gauge Column Co. in Bulletin 516B are boiler water columns and gage equipment. Illustrates and describes water columns for all pressures, as well as remote reading gages, liquid level alarms, water gage illumination equipment, and electrode-type liquid level alarms.

348 Guide to Gages — Catalog 300-B, 112 pp, features Ashcroft, Dura-gauges, Maxisafe, pneumatic receiver, recording, drawn case, chemical and special application gages of Manning Maxwell & Moore, Inc. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in.

349 Motor Operators, Valves — Catalog 407, 24 pp, describes electric motor operators and motorized valves of Schade Valve Mfg. Co. and introduces the Type 2RD, a reversible, proportional unit. Fully illustrated, booklet covers features, construction details, applications, dimensions. Valves described include butterfly, rotary disc, balanced globe, three-way, fuel control, others.

350 Automatic Controls — Selection and application information on automatic controls for steam and water service is presented by The Powers Regulator Co. in this 46-pp Engineer's Manual. Covers controls for fuel oil heaters, heat exchangers for cooling, instantaneous heat exchangers, jacket water cooling, process hot water, pressure reduction, storage heaters, as well as for two temperature hot water systems.

351 Feedwater Regulator — Bulletin 1045 released by Copes-Vulcan Div., Blaw-Knox Co., describes a feedwater regulator with two-element regulation, one control element responding to changes in rate of steam, the other to variations in boiler water level. Diagram and specifications included.

352 Nuclear Instrumentation — Detailed information on nuclear instrumentation and accessories is presented in 50-pp Condensed Catalog F of Tracerlab, Inc. Covers all phases of nuclear study and includes detectors, counting and radiation analysis equipment, sample changing equipment and necessary adjuncts for personnel protection, monitoring.

353 Instruments and Controls — Catalog 57-6, Republic Flow Meters Co., describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorder, temperature recorder, multipoint gages and others. Includes descriptive data.

354 Instrument Tubing — Detailed information on various types of instrument tubing and accessories is presented in this 16-pp bulletin. Among tubing described is extruded polyethylene tubing, extruded nylon tubing, tubes of copper, aluminum, and/or steel with polyethylene sheath, tubing with vinyl sheath, bundled instrument tubing-products of Dekoron Products Div., Samuel Moore & Co.

355 Process Control Systems — This 12-pp booklet of Daystrom, Inc., outlines company's industrial process control systems, covering such subjects as the benefits of a total systems approach, what is meant by a single-source responsibility, and an explanation of this company's guarantee of 99 per cent operational availability. Discusses flexibility of a typical control system, listing the control-associated functions performed.

356 Continuous Stream Analyzers — Illustrated and described in 8-pp Bulletin CL-4000 is a line of continuous stream analyzers, including pH equipment, gas chromatographs, infrared analyzers, oxygen analyzers, electrolytic hygrometer, flow colorimeter, and thermal conductivity gas analyzer. Typical applications are listed by Beckman Instruments, Inc.

357 Control Centers — Described in 22-pp Bulletin C11, Webster Engineering Div., Midland-Ross Corp., are control centers and systems for combustion safeguard and automation. Advantages of custom engineered control centers and systems are covered, and design data and starting sequence on nine typical installations included.

358 Compiler-Translator — Act I, an electronic algebraic compiler and translator, is described in 18-pp Manual S-520 of Royal McBee Corp. Explains "source" program language — a series of algebraic and logical statements. Stresses simplicity of use, faster programming and thus faster computer solutions to engineering and control problems.

359 Computer Control System — Details on PowrMag solid state analog computer control systems are presented in Bulletin MSP-163, Hagan Chemicals & Controls, Inc. Provides diagrams showing interchangeable circuits possible for various control functions. Applications to industrial process control are suggested, with emphasis on centralized plant or multi-plant control, expansion of facilities.

360 Automation Components — A 30-pp reference for automation components and control systems, Condensed Catalog D-31 describes latest timing components and linear measuring systems for industrial use available from Automatic Timing & Controls, Inc. Sections are devoted to electronic timers, special timers and their applications, package control systems, test equipment, controllers, contactors and valves.

361 Teaching Servo Systems — A new method of teaching servo systems that bridges the gap between theory and practice is described in 8-pp Special Report SR-3 by Servo Corp. of America. Explains how packaged assembly of electronic and electrochemical components permits students to build and test servo systems, demonstrates formula derivation, characteristics of control systems.

362 Data Processing at Work — Data processing equipment of Leeds & Northrup Co. now in use throughout the country is described in 48-pp Preliminary Technical Publication N-07(1). Installations covered include digital data processing and analog and digital computing systems. Explains types of inputs, input switching, output devices and modes of operation for applications in electric-power, petro-chemical, other fields.

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363 Indicating-Alarm System — Features and advantages of the Omni-guard indicating and alarm system by Thomas A. Edison Industries for monitoring temperatures and pressures are illustrated and described in Publication 3036C.

364 Alarm/Control System — Bulletin ECM 119, about 16 pp, of General Electric Co., describes a high-capacity alarm/control system providing an inexpensive method of locating faults at unattended operations and controlling on-off functions remotely. Tells how equipment can be "customized" to suit specific supervisory or control needs.

365 Data Logging System — Technical data on all functions of the Kybernetes Series 2000 Data-Logging System are presented in this 12-pp bulletin by Hagan Chemicals & Controls, Inc. Covers inputs, d-c amplification, analog-to-digital conversion, linearization, programming, integration, computer control and others Specifications for components and functions of system included.

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Water Management

366 Annunciator Systems — Well illustrated with photos, charts and diagrams, 52-pp Catalog 100C of the Panalarm Div., Panellit, Inc., presents information on annunciator systems designed to give immediate notification of off-normal conditions in continuous process and automatic operations. Discusses function and applications of annunciators and types of equipment.

367 Lamp Annunciator Systems — Bulletin A-200, 24 pp, presents outstanding features and operational details of modular industrial lamp annunciator systems for supervision, process control automation systems available from Edwards Co., Inc. Several models of annunciators are covered, also relay cabinets and audible signals. Includes system selector chart, ordering information.

368 Remote Indication Logging — Application of automatically programmed remote indication logging system for operation in conjunction with its space-code selector supervisory equipment is told in General Electric Co.'s Bulletin GET-2925, 8 pp. Includes information on coding; master and remote station components; adding to existing systems; physical arrangements, control power, operating voltages and channels.

369 Signaling Equipment — Air and electric signal systems and specifications of horns, bells, buzzers, chimes and sirens are featured in 88-pp Catalog 160 by Sperti Faraday, Inc. Included are sections on gravity drop and lamp type annunciators and accessory equipment, and charts and diagrams for selection of proper type signal for various background noise levels and work areas.

When ordering catalogs, allow time for us to relay your requests to the manufacturers—and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

370 Annunciator Systems — Comprehensive information on operation and application of annunciator system to provide continuous and automatic surveillance of pipeline, chemical and food processing, power generation and distribution is given by The Scam Instrument Corp. in 36-pp Catalog 659. Types of annunciator sequences are illustrated and described, annunciator diagrams included.

371 Computer Talk — This 22-pp glossary of "computerese" — the language of electrical brains — is compiled by Minneapolis-Honeywell Regulator Co. to make computer language more intelligible to the layman. Defines over 82 terms found in the vocabulary of industrial process computer engineers.

372 Ultrapure Feedwater — Technical Reprint T-178 of Graver Water Conditioning Co. covers research problems relating to production and quality control of ultrapure feedwater for Eddystone Station. Presents pilot plant data on filtration and demineralization process for treating condensate. Specific plant-scale design features are described as well as analytic ways to measure condensate, quality.

373 Feedwater Heaters — Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and nondeaerating type are presented in 12-pp Bulletin 117A of Stickle Steam Specialties Co. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions.

374 Sodium Zeolite Softeners — Described in 12-pp Bulletin 4520 by Cochrane Corp. is the sodium zeolite process of water softening. Includes information on selecting and sizing of equipment, automatic vs manual controls and calculations of softening capacity.

375 On Zeolite Softeners — "Care and Operation of Zeolite Softeners," covers bacterial fouling, deposits encountered and operational factors in relation to this equipment. Prepared by Betz Laboratories, Inc., it tells too, how exchange material should be handled to maintain maximum efficiency and longer equipment service.

376 Water Requirements Calculator — With this calculator you can quickly figure conversion of ppm water hardness to grains per gallon hardness, amount of exchange resin needed, brine and salt requirements, and brine tank size and operating brine level adjustments. Calculator, prepared by Morton Salt Co., can also be used in selecting tank size for liquid volume problems. Morton Salt Co.

377 Control Assembles — Controls or water conditioning and ion exchange systems are described by Permutit Co. in 12-pp Bulletin 4543. Covers panels and cubicles containing centralized instrumentation for automatically controlling, recording, signaling and monitoring system operations.

378 How Corrosion Attacks — In this data sheet, Betz Laboratories, Inc., explains how and why boiler, cooling and process water systems are constantly plagued by corrosion. Discusses such factors as pH, dissolved solids, temperature, flow rate, dissimilar metals, CO_2.

379 Ion-Exchange Controls — In Bulletin E-158, Illinois Water Treatment Co., describes automatic control systems for ion-exchange equipment. Standards designed to assure proper performance of control units are detailed, and various elements in the control cabinets, as well as the power-operated units, are described. Specifications for electrical controls are also included.

380 Deaerating Heaters — In 8-pp Bulletin WC-101C, Graver Water Conditioning Co. discusses principles of deaeration, deaerator operation, standard designs available, design features and accessory equipment. It is illustrated with drawings and photos of installations.

381 Boiler Water Treatment — Chemical reduction of oxygen in boiler feedwater with hydrazine is the subject of 10-pp Bulletin BW of Fairmount Chemical Co., Inc. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details covered.

382 Water Treatment — Process Bulletin C2 describes a comprehensive method for treating and protecting recirculating water equipment and process water systems. Application methods are described by Nalco Chemical Co.

383 For Feedwater Analysis — Bulletin 148BP, Cambridge Instrument Co., Inc., contains a technical discussion of manufacturer's analyzers for determination of dissolved oxygen and hydrogen in feedwater. Discusses both O and H units as to function, ranges, accuracy.

384 Corrosion Control Method — This data sheet of Betz Laboratories, Inc. discusses Dianodic method of corrosion control and its use in open recirculating cooling water systems. Variations of the Dianodic method to meet specific requirements and cope with variables that enter into corrosion problem are covered.

385 Automatic Treatment Control — Methods for automatic control of water treatment plants are discussed in 8-pp Technical Reprint T-179 by Graver Water Conditioning Co. In two parts, Part I deals with control of demineralization plants and covers "stepless" regeneration, regeneration, quality control of effluent, conductivity pH control, automatic regeneration. Part II considers control of cold process softening and clarification units, hot process-hot zeolite systems and sodium zeolite systems.

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386 pH and Chlorine Control — The 14th edition of W. A. Taylor Co.'s handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and test kits are illustrated. Methods are also outlined for quantitative analyses of phosphate, calcium, magnesium, silica, nitrate, hardness. Available to qualified power engineers, please state your job title.

387 Treatment Instrumentation — Provided in 30-pp Booklet D97-2 of Minneapolis-Honeywell Regulator Co. is a compilation of article reprints on instrumentation for treatment of water and sewage. What instruments are used, how they are used and their functions in controlling automatically the many variables encountered in the treatment process are covered in detail.

388 Water, Sewage Treating — Water, sewage and industrial waste treatment equipment of Link-Belt Co. is described in 20-pp Book 2617. Contains illustrations and photos of latest sanitary engineering equipment and shows flow diagrams of installations in typical water, sewage, and industrial waste treatment plants.

389 Putting Effluent to Work — Use of sewage plant effluent for boiler and cooling purposes is discussed by Betz Laboratories, Inc. in Technical Paper 138. Tells how effluent can be used satisfactorily in recirculating cooling systems and as boiler makeup provided it is adequately treated to avoid organic growths, deposits and corrosion in cooling systems and foaming, carryover and ammonia corrosion in boiler and steam systems.

Cooling Towers

390 Double-Flow Aquatower — Bulletin DFA15-60 describes The Marley Co.'s double-flow Aquatower designed to bridge the gap between standard double-flow Aquatowers and unlimited capacity industrial cooling towers. Specifications and engineering data included.

391 Cooling Tower Economies — Presented by Hamon, Inc. in this 12-pp bulletin is a discussion of economic comparisons on cooling towers for a utility. Compares natural draft and mechanical draft towers to various approaches and includes detailed cost comparison curves, offers conclusions based on this data.

392 Cooling Towers — Performance details on cross-flow cooling towers of The Marley Co., are presented in this 20-pp illustrated Booklet CF-59. Discusses and illustrates through diagrams the cross-flow principle of water cooling, and includes descriptions of equipment, engineering and design features.

Construction Materials

393 For Roof, Wall Construction — Included in this literature file offered by Elwin G. Smith & Co., Inc. are product bulletins describing roof and wall construction materials. Bulletin 59C covers corrugated sheets; 59W, insulated walls and metal panels; 595, insulated sandwich curtain walls and roofs; Bulletin 60D, steel and aluminum roof deck; Bulletin 60F, high-strength permanent steel forms for concrete roof and floor slabs; and Bulletin 60R, conveyor hoods and curved corrugated sheets.

394 For Masonry Anchoring — Catalog 25 is a 48-pp pocket-sized handbook of anchoring and drilling devices produced by The Rawlplug Co., Inc. for fastening anything to masonry. Includes tables showing proper anchors for each type of fixture and material, and gives dimensions, etc.

395 Aluminum for Architecture — Comprehensive information on aluminum alloys and surface finishes is provided by Olin Mathieson Chemical Corp. in this 20-pp booklet. Contains guides to mechanical finishes, as well as descriptions of textures, bright or satin surfaces. Electrochemical and chemical finishes with recommended coating for varying architectural exposures are listed. A section on applied finishes covers porcelain enamel, baked enamel and primers.

396 Watertight Masonry — Major considerations in designing tight masonry walls are covered by The Master Builders Co. in 6-pp Bulletin O.M.-8A. Discussed are mortar ingredients and proportioning, compatibility of brick and mortar, control of shrinkage and bleeding, separation cracks, effect of mechanical disturbances.

397 Masonry Fasteners — Fifty-pp pocket-size Catalog 160 of Diamond Expansion Bolt Co., Inc. lists anchors and fasteners for masonry and hollow walls. Covers machine screw anchors, lag screw expansion shields, machine bolt expansion shields, closed back machine bolt expansion shields, masonry drills, and a variety of anchors. Fully illustrated, includes application information, size data.

398 Water-tight Sealant — Physical properties and characteristics of A. C. Horn Companies' two-component synthetic rubber compound based on liquid polysulfide polymer for use in sealing joints where an absolutely water-tight seal is required are detailed in 16-pp Bulletin 6543. Lists advantages.

399 Grouting Methods — Effective methods for grouting the different basic types of heavy industrial equipment are explained with text and photos by The Master Builders Co. in 8-pp Bulletin EPMG-2A. Advantages of the pre-mixed grout are explained, and diagrams, charts and photos cover preparatory steps, forming, selecting materials, mixing and placing the grout.

400 Handbook on Waterstops — In the 24-pp Kwik-Seal Waterstop Technical Manual of The Gates Rubber Co. is a wealth of practical information on waterstops and their use. Covers size and shapes of the waterstop, comparative data for rubber and plastic types, handling and storage of the material, design data for both "little" and "considerable" movement joints, application data for installation. Booklet also deals with various splicing methods.

Handling Equipment

401 Elevator Rope Guide — When elevator rope should be retired, lubrication, safety factors, diagrams, and specifications are covered in Elevator Wire Rope Book E-10 of Macwhyte Wire Rope Co. It offers practical suggestions covering repair and maintenance of passenger and freight elevators.

402 Industrial Truck Costs — A library of information on figuring industrial truck costs is presented in four recently published bulletins — 62 pp in all. Includes factual industrial truck cost histories and do-it-yourself formulas for quick, accurate calculation and comparison of all expenditures in owning, operating and maintaining trucks powered by electricity, gasoline, propane. Bulletins are offered by Exide Industrial Div., The Electric Storage Battery Co.

403 For Overhead Handling — Illustrated and described by Manning, Maxwell Moore, Inc., in 20-pp Bulletin 15025 are hoisting products for overhead load handling. Included are descriptions of electric hoists, air hoists, chain blocks and hoist accessories, lever operated hoists, chain blocks, electric and air operated cable type hoists, and lifting specialties.

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Maintenance, Shop Equipment

404 Heavy-Duty Electric Tools — Twelve-pp Condensed Catalog G20 illustrates and describes heavy-duty electric tools, including drills, saws, shears, hack saws, generators, grinders, hammers, screw drivers, nut runners, sanders and polishers. Detailed specifications are included. Milwaukee Electric Tool Corp.

405 Tips on Grinding Wheels — Over 1600 abrasive wheel recommendations for grinding everything from agate to zirconium are set up in alphabetical order by The Carborundum Co., in this specification catalog, about 57-pp. Material, work, operation — with their respective recommendations on abrasive, grit, grade and bond — are listed.

406 Guide to Preheat — Welding of low-alloy high-tensile steel and other alloy steels with the aid of preheat is explained by J. B. Nottingham & Co., Inc., in 40-pp "A Guide To Preheat". Physical and chemical changes that take place in these problem steels during and immediately after welding are outlined.

407 Tool Buyers' Guide — Catalog 60, complete with specifications and prices, is a 68-pp ordering book on Double Circle tools of Chicago Latrobe. Covers drills, reamers, end mills, countersinks, carbides, counterbores, others. Well indexed and illustrated, catalog also provides information on features and applications; includes section on drill facts.

408 Grinding Wheel Chart — Information contained in this chart is based on rules and regulations established by the American Standard Safety Code for use, care and protection of abrasive wheels. Prepared by the Grinding Wheel Institute, it lists "do's and don'ts" of grinding wheel care.

409 Conduit Bending — Illustrated Bulletin 260, on bending conduit or pipe easily and accurately, features an improved bender. Prepared by Lidseen of North Carolina, booklet covers calculating lengths of legs, locating bend, back-to-back method, back-to-back push-through method, others.

410 How to Bend Conduit — This 12-pp pocket-size booklet of Appleton Electric Co. gives instructions for making precision bends in electrical metallic tubing, rigid steel, and rigid aluminum conduit. Covers five fundamental bends — angle bends, stub lengths, back-to-back bends, offsets and three-bend saddles. Diagrams show techniques for on-the-spot bending of small conduits. Includes offset formulas, shrink tables and "gain" tables.

411 On Welding Electrodes — Contained in this 64-pp electrode pocket guide is information on all types of electrodes including mild steel, low alloy, low hydrogen, iron powder, stainless steel, hardfacing, non-ferrous and cast iron. Published by Air Reduction Co., Inc., it covers applications, procedures and pertinent data on each electrode, includes charts of recommended electrodes for welding various steels, and tables for mild steel and hardfacing electrodes.

412 Arc Welding — Basic information concerning arc welding techniques for small diameter piping is contained in Lincoln Electric Co.'s Bulletin 2112.3. Lists advantages of welded piping installations; describes procedures, explaining calculation of welding costs with chart resume of information for schedule 40 pipe 1 in. through 6 in. diameter; and recommends suitable types of electrodes.

413 Brazing Techniques — This 24-pp manual contains data for brazing shapes, sheet, castings, tubing and assemblies of aluminum, cast iron, copper, brass and steel. Covers such basic functions as heat, flame and torch settings, alloys selection and joint design. Solutions to common brazing problems are answered by All-State Welding Alloys Co., Inc.

414 Equipment for Welding — Gas welding, cutting and allied equipment of Smith Welding Corp. is covered in this 40-pp manual. Book is arranged in six sections and with it is a 6-pp full-color insert showing cutaways of major products. Charts and technical data are also provided. One section is devoted to flow capacity curves for gas pressure regulators.

415 Manual Welding Equipment — Described in 20-pp Catalog F-8982E is Linde Co.'s manual welding equipment using an inert gas to protect the weld zone from the atmosphere. Various types of welding torches and accessories suitable for welding of all commercial metals are covered.

416 Vest Pocket Welding Guide — This revised edition of "How to Get Better Welds," published by Hobart Brothers Co., contains 80 pp of arc welding information. Covers essentials for proper welding procedures, good and bad welds, welding positions, operator qualifications, welding metals and steel available for welding. Also deals with causes and cures of common welding troubles, check points for quality welding, cost saving, safety precautions. Electrodes and factors to consider when selecting them are discussed, as are welding wires and flux, power sources.

417 Soldering Tools — Catalog S-60 of Ungar Electric Tools contains 8 pp of detailed information on soldering tools featuring interchangeability. A temperature chart for various applications is included.

418 Maintenance Equipment — Catalog No. P-9, 24-pp, contains descriptions of pulling systems, photographs showing Grip-o-matic and push-pullers, Power-Twin "center hole" rams, pumps and hydraulic shop presses offered by Owatonna Tool Co. Shows how these units remove and install gears, bearing, pulleys, shafts and couplings simply and quickly. Heavy duty industrial wrenches are also described.

419 Flame Spraying Processes — Basic engineering and application data on flame-sprayed coatings of metals, ceramics, carbides and other high melting materials is presented in 16-pp Bulletin 136B by Metallizing Engineering Co., Inc. In addition to covering basic engineering considerations for each process, it includes tables and charts covering the specific characteristics of each.

Packings, Seals, Gaskets

420 Packing Chart — This packing recommendation chart by Raybestos-Manhattan, Inc., shows proper packing types for specific applications. The chart suggests seven basic packing types for 95 per cent of all packing needs, including such applications as: pumps and valves, high-temperature valve stem and expansion joints, high-speed rotary air compressors, corrosive and viscous liquids, chemicals, gasket applications, and hydraulic and pneumatic equipment.

421 Corrosion Resistance Chart — Over 150 chemicals and their recommended usage with ductile iron, iron, steel 316 and 304 stainless steel, Monel, brass, bronze, copper, aluminum and plastisol plastic are listed in Corrosion Resistance Chart J-CRC. Prepared by OPW-Jordan Corp., chart shows which gasket materials are needed for various chemicals when Kamlok couplers are used and which O-ring materials are needed when swivel joints are used.

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422 On Boiler Gasket Leakage — Some causes of boiler gasket leakage are discussed in Technical Paper 139 by Betz Laboratories, Inc. Factors to consider in overcoming or minimizing gasket leakage, such as selection of gasket joint, installation, and corrosion protection, are explained in detail.

423 O-Ring Handbook — Catalog 5711 is a 24-pp design and data book of Parker Seal Co. on Viton O-rings. Contains test information on some 150 fluids and gases to which this synthetic elastomer is compatible; recommended design techniques; general information on three compounds and dimensions; and data on all standard sizes.

429 Mechanical Packing Guide — Johns-Manville's 64-pp catalog, Form PK-131A, contains comprehensive information on mechanical packings and is generously illustrated. Includes chemical selection chart listing more than 700 liquids common to process industries. Also featured is a simplified packing selection chart to help relate particular operating conditions to the most suitable packing.

430 Mechanical Packings — Catalog P-210C, Raybestos-Manhattan, Inc. contains 40-pp of detailed information on mechanical packings and gasket materials. It contains illustrations, descriptions, complete service recommendations and specification charts.

Motive Power

424 Large Generating Units — Design and construction features of large steam turbine generating units are illustrated and described in 40-pp Bulletin 03B9448, Allis-Chalmers Mfg. Co. Subjects covered range from compact component design to controls and instrumentation. Illustrated with photos, drawings and section diagrams. Booklet includes tables of ratings.

425 Gas Turbines for Peaking — Peaking combustion gas turbines with capacities from 7,000 to 28,000 kw are described in 12-pp Bulletin GED-3761, General Electric Co. Outlines savings possible through lower installed cost, minimum space and personnel requirements, less transmission equipment investment, lower line losses, and lower standby.

426 Gas Turbine Power — Eight-pp Bulletin GEA-7083 of General Electric Co. introduces a line of 75 to 20,000-hp ultra-lightweight, compact gas turbines for a wide variety of applications, including fluid and gas pumping, electric power generation. Covers design features, performance and operating characteristics, current and potential applications.

427 Steam Turbines — Advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined by The Terry Steam Turbine Co. in illustrated Bulletin S-140. Describes various models in their line and includes application photos.

428 Steam Turbines — Single stage turbines for mechanical drives are featured by Murray Iron Works Co. in 6-pp Bulletin T-126. Schematic drawings showing component features and details of operation and design included.

431 Gas Turbines — The power concept of The Cooper-Bessemer Corp.'s gas turbine based on the J-57 jet engine is discussed in 8-pp Bulletin 95. Describes operating characteristics, thermal efficiencies, maintenance costs, and potential applications, and includes schematic drawings, performance curves and engineering data on the units.

432 Standby Generator Sets — Described by General Motors Corp. in this 8-pp bulletin is a line of diesel powered standby generator sets for emergency power. Gives complete specifications on single and multiple-engine standby generator sets.

433 Gas Turbine Engines — Featured in this 24-pp bulletin of Solar Aircraft Co. are engine data, performance curves and applications for gas turbine engines. Explains operation of gas turbines and includes application photos.

434 Natural Gas Engines — Applications of natural gas engines in gas compressor, pipeline, air conditioning, sewage disposal, gas separation, electric, standby and other installations are detailed by Caterpillar Tractor Co. in 8-pp Booklet 20173. Includes basic specifications for natural gas engines, fuel consumption curves.

435 For Standby Power — Selection and installation of standby electric plants and controls is fully detailed in this 8-pp bulletin by D. W. Onan & Sons, Inc. Practical suggestions are offered on planning and designing the installation, items to evaluate to meet particular requirements are listed, and advantages of gasoline and diesel-powered generator sets described.

Safety, Fire Protection

436 Personal Safety Equipment — Catalog 59, 76-pp, of Wilson Products Div., Ray-O-Vac Co., covers four general types of personal safety equipment: eye protective wear; respiratory protection; hearing protection; and headgear Detailed product descriptions show individual components and parts, and charts recommend specific equipment for each hazard.

437 Equipment for Linemen — This 32-pp catalog of Charleston Rubber Co. describes high voltage rubber protective equipment for linemen, giving instructions as to its proper care and use. Also lists technical reports available, including a glove care poster, and provides a glove selector chart, ordering instructions and current price list. Among products featured are gloves and sleeves, glove protectors and innerliners; danger flags.

438 For Fire Protection — Folio 1 of Chemetron Corp.'s Cardox Div., is a 12-pp revised booklet on fire extinguishing systems and equipment. Lists principal causes of large-loss fires, advantages in use of carbon dioxide, and examples of extinguishing installations in steel, general manufacturing, electrical and other industries. Shows typical systems for protection of generators, flammable liquids, pumping operations, etc.

439 Fire Alarm Systems — Publication 246 of The Standard Electric Time Co. contains 36 pp of detailed information on fire alarm systems for critical applications in industrial, institutional and other public buildings. Contains typical job specifications covering all systems.

440 Handling Flammable Liquids — Problems involved in use of flammables and methods and equipment required for safe control are described by The Protectoseal Co. in this 76-pp safety handbook. Physical properties and characteristics of most commonly used flammables are detailed, and recommendations for safe handling of these liquids given.

441 Fire Protection Equipment — Power plant fire protection systems are described in this 6-pp bulletin released by Cardox Div., Chemetron Corp. Describes protection for generators and supplementary equipment, as well as generator purging and coal bunker inerting.

442 Fire Extinguishing Equipment — Shown by Ansul Chemical Co. in 20-pp — Catalog 1960 are hand portable extinguishers, stationary fire equipment, piped systems, and large capacity mobile equipment such as fire jeeps and trucks. Capacity data on various types of extinguishers and other equipment presented.

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443 Fire Control Tips — This fire control chart, AD3003R8, shows fire extinguishers and gives detailed information including ratings. Prepared by Walter Kidde & Co , Inc., gives data on Class A, B and C fires and extinguishers suitable for each class of fire.

444 Special Fire Protection — Devoted to special hazard fire protection, this 44-pp booklet of Grinnell Co., Inc. covers both equipment and methods. Tells how to recognize special fire-hazards conditions in a plant. Discusses in detail major types of fire protection, telling how each functions, giving it advantages and limitations, and illustrating examples of use.

445 Chain Safety Kit — Answers to questions regarding the care, use and inspection of sling chains are given by The McKay Co. in this safety kit. Consisting of five folders, each dealing with a different aspect of chain safety, it covers inspection procedures, safety cautions, safety terms, working load limits, proper care and use of chain, and maintenance procedures.

446 Fire-Retardant Paints — Twelve-pp pocket-size Bulletin 100 of The Albi Mfg. Co., Inc., tells how fire-retardant paints reduce potential fire damage. Explains significance of the "safety margin" of extra time at start of a fire as related to protective action of the paints on both combustible building material and structural metal.

When using the Reader Service Cards, please be sure to give your company name and job title, even if you want catalogs sent to your home. Manufacturers prefer to send literature to those who identify themselves

447 Color for Safety — Offered by Valdura Heavy-Duty Paint Div., American-Marietta Co., this 6-pp booklet shows a cutaway section of a typical industrial plant with all danger areas painted in appropriate safety colors. Lists recommended colors for every safety application, and gives tips on good housekeeping.

448 Self-Sticking Identification — Products designed to aid in industrial maintenance and safety identification programs are illustrated and described in 32-pp Catalog 520 of W. H. Brady Co. Covers piping marking systems, identification of plant wiring and electrical equipment, lubrication marking, marking for hazardous areas and equipment.

449 Markers, Signs — Illustrated in full color, this 24-pp catalog of North Shore Nameplate Div., Anodyne, Inc., provides information on pipe and electrical markers, numerals, letters, safety and identification signs all available from stock. Explains how markers are applied, also includes prices, information on ordering these products.

Maintenance Coatings and Cleaners

450 Coal-Tar Coatings — Bulletin CAC-11-958, 14-pp, describes coal-tar protective coatings of Plastics & Coal Chemicals Div., Allied Chemical Corp. Primarily moisture barriers and impervious corrosion proofers, these coatings are particularly suitable for buried or immersed steel and concrete structures. Booklet lists specifications, resistance properties and typical industrial applications for expanded cold-applied coal-tar coatings.

451 Corrosion Resistant Coatings — Latest developments in corrosion resistant coatings, treatments for floors, and coatings and waterproofing for masonry are described in 72-pp Form 990 of Truscon Laboratories Div., Devoe & Raynolds Co., Inc. Presents detailed information on maintenance products available for interiors, floor coatings, exteriors, new construction, other uses.

452 Protection Against Rust — This 38-pp treatise (Form 259) on rust and corrosion control by protective coatings shows actual color standards of Rust-Oleum Corp.'s primers and top coatings. Covering water resistant, heat resistant floor coatings, heavy-duty chemical resistant coatings, galvanized metal coatings, wire fence roller coatings, and quick-dry coatings. Bulletin contains full-color application photos and 110 color chips, and technical section giving data on surface preparation for various types of surfaces, application techniques, how to estimate gallonage needed.

453 Efflorescence, Chalking — Causes of efflorescence and early chalking on painted masonry surfaces, and ways to overcome and prevent such deterioration are explained by Rohm & Haas Co. in this 48-pp booklet. Discusses paint formulation and compares four major types of emulsion vehicles for resistance to alkali, moisture, heat, and ultra-violet light. Also covers film swelling, film coalescence, paint stability in presence of soluble salts, pigmentation, pigment volume concentration.

454 Aluminum Paints 'n Color — Protective and decorative advantages of painting with aluminum in color are discussed by Aluminum Co. of America in Form 30-11451. Illustrated in full color, shows examples of use of this metal-bright paint on industrial structures suggests other uses. Tells how to apply the paint, how much to use.

455 Painting Galvanized Steel — Effective techniques for painting galvanized steel sheets, are explained in this 16-pp booklet, produced jointly by the American Iron and Steel Institute, the American Zinc Institute, and the National Paint, Varnish and Lacquer Ass'n. Discusses main reasons for this painting: appearance, heat reflection, longer service. Provides tips on selection and application of paints.

456 Masonry Treatments — Waterproofing, protective and corrective treatments for masonry are described by Standard Dry Wall Products, Inc. in this 22-pp specification guide. Circular 17 describes products and their applications, includes photos of typical applications, and suggested specifications.

457 For Chemical Cleaning — Technical Bulletin 102, about 16-pp, presents application and other information on products of Chas. Pfizer & Co., Inc. for chemical cleaning. These include formulas for power plant cleaning, stainless steel cleaning, aluminum and aluminum alloy cleaning, alkaline derusting and paint stripping, general cleaning, others. Also provided is chart of corrosion rates of various metals and alloys.

Hose and Fittings

458 Hose, Fittings, Couplings — Industrial Catalog 204, about 40-pp, contains information on hose, fittings, self-seal couplings and related products of Aeroquip Corp. Provides specifications on products for general industrial applications, power plants, others. A hose selector chart lists applications and fluids for which specific hose types are recommended. Instructions for ordering and assembling hose lines are also given.

459 Hose and Fittings — Comprehensive data on The Weatherhead Co.'s hose and hose assemblies, brass and steel tube fittings, hose and tube working tools, stock cabinets, hose racks and other specialty products are presented in 128-pp Catalog C-300. Profusely illustrated, it contains hose selector chart, assembly data chart, detailed specifications, application and installation instruction. Available to qualified power engineers, please state your title when requesting this catalog.

Crushing

460 Shredders, Crushers — Bulletin 257 describes and illustrates hammermills and shredders, rolling ring and special crushers for reducing chemicals, minerals, ceramics, and other materials including wood waste. A publication of American Pulverizer Co., bulletin discusses construction features of the equipment.

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461 Crushing Handbook — This 40-pp Handbook of Crushing by Pennsylvania Crusher Div., Bath Iron Works Corp., covers the subject of mechanical size reduction, describing various reduction methods — impact, attrition, shear and pressure — and many kinds of crushing equipment. Illustrated with diagrams and charts, it contains data on closed circuit crushing systems, factors in selecting crushing methods for particular applications and materials

462 Coal Sample Crusher — How you can save on your fuel bill and power cost with company's coal sample crusher is explained in Bulletin CS2. Illustrated with photos and dimensional diagrams, discusses operation and features. Bulletin is offered to power engineers by Gruendler Crusher & Pulverizer Co.

Engineering Office Equipment

463 Reproduction Materials — Drawing and document reproduction material of Eastman Kodak Co. are featured in this 20-pp bulletin. A reproduction materials selection chart lists a variety of reproduction jobs, type of equipment to be used and materials needed.

464 Facts About Microfilm — "Let's Take a Positive Look at Microfilm" is an article reprint offered by Minnesota Mining and Mfg. Co. discussing merits of using microfilm as an active tool of business and industry. Typical applications shown.

465 Keep it Clean — How to clean and protect engineering drawings is told by Keuffel & Esser Co. in this 6-pp folder. Describes cleaning aides and protective spray, giving ordering information, prices.

466 Typing Engineering Symbols — A method of using an electric typewriter for quick, convenient typing of special symbols and equations needed in the field of engineering is the subject of this 8-pp bulletin of Sperry Rand Corp.'s Remington Rand Div. Describes variety of symbols which can be snapped on.

Another Reference File of Commercial Literature is in preparation and will appear in a few months. The editors welcome your suggestions for making this department of greatest value to you

Steam Boilers, Heat Exchangers

467 Packaged Generators — Bulletin MH 3-54, 14-pp, gives detailed coverage to Union Iron Works' Type MH packaged water tube steam generators which are finished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions.

468 Automatic Boiler — Application of the Coal-Pak automatic package boiler to low-pressure steam heating, hot water heating, and high-pressure process steam is covered by Bituminous Coal Institute in 36-pp Guide Specifications GS-3. Sample specifications included, coal and ash handling, wiring, and boiler room layouts.

469 Automatic Boilers — Powermaster Model 3 packaged automatic boilers are described by Orr & Sembower, Inc., in 12-pp Bulletin 1260. Boiler types, including gas, oil and combination gas-oil models, a specially-designed hot water boiler, and steam atomizing principle for use with No. 6 oil are included. Ratings and dimensions of all sizes given.

470 Hot Water Boilers — Twenty-pp Brochure HCC-2 of Combustion Engineering Co., Inc. describes and illustrates design, construction, advantages and economies of the C-E La Mont controlled circulation hot water boiler. The unit is for supplying high pressure, high temperature water for heating and process uses.

471 Packaged Steam Generator — The performance story of a prototype stoker-fired packaged steam generator in one typical installation is told by Foster-Wheeler Corp. in 8 pp Bulletin PG-59-4. An evaluation of performance is presented.

472 Packaged Boilers — A complete discussion of firetube boilers — from construction features to final test and start-up service — is presented in 12-pp Bulletin Form AD-178, Cleaver-Brooks Co. Full-color cutaway drawings illustrate features and design of packaged boilers through 600 hp for heating and processing, steam or hot water.

473 Package Boilers — This 12-pp booklet on package steam generators describes the formulas behind all package steam generators. Published by Crane Co.'s Cyclotherm Div., it tells how installation of a package steam generator can raise steam capacity in an existing boiler room.

474 Steam Generator — Bulletin F-14 contains 32 pp of detailed information on E. Keeler Co.'s water tube type steam generator. Photos and diagrams illustrating design and construction features are included.

475 Heat Exchangers — Shell and tube heat exchangers, including copper base alloy, steel and stainless steel fixed tube bundle heat exchangers, are illustrated and described by The Young Radiator Co. in 16-pp Catalog 1258A. Includes tables of pressure ratings and material specifications for steam service heat exchangers, selection data, oil viscosity graph, tables of weights and dimensions.

476 Heat Exchangers — Engineering Manual PB-EM 102-A, The Carbone Co., contains 22 pp of illustrations, cutaways, diagrams and design data on Polybloc impervious graphite heat exchangers, corrosion-resistant, high thermal conductivity units. Provides charts, graphs, typical calculations, examples and specifications. Covers principles of operation.

477 Industrial Heat Exchanger — This selection data form of The Air Preheater Corp. covers industrial heat exchangers, including a package regenerative air preheater for industrial process or boilers in a range from 25,000 to 250,000 lb per hr; recuperative type heat exchangers for high temperatures, high pressure applications where leakage cannot be tolerated; and a compact rotary regenerator.

478 Heat Transfer Equipment — Design and construction features of heat transfer equipment are detailed in 20-pp Bulletin HE-8 of Henry Vogt Machine Co. Covers the positive seal baffle, film type heat exchangers, waste heat boilers, high pressure and high temperature heat exchangers, exchangers of special alloys.

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Mechanical Power Transmission

479 Improved Drives — Catalog GB-201-A, Browning Mfg. Co., contains 58-pp of selection data on Gearbelt drives which combine flexibility of belt drives with advantages of chain and gear drives. In addition to specifications, it contains design and installation suggestions, engineering data.

480 Variable Speed Drives — Designated M-592, this 96-pp catalog explains through copy, photos and drawings the wide assortment of styles, modifications and accessories available in mechanical variable-speed Motodrives offered by Reeves Pulley Div., Reliance Electric and Engineering Co. Includes construction features, speed and rating tables, and pricing information.

481 Fluid Drives — Well illustrated 20-pp Bulletin A-719, on American-Standard's Class 4 adjustable speed Gyrol fluid drives, discusses principles of operation and shows typical applications. Horsepower and inertia starting capacity curves are provided. Components of the unit are illustrated. Selection guide charts are presented for both variable torque and constant torque applications.

482 Magnetic Drives — Performance data on magnetic drives designed to provide overload protection even under extended full stall are presented in 12-pp Bulletin TP-1-60 by Tormag Products Div., Gleason Reel Corp.

483 Shaft-Mounted Reducers — Modern methods of speed reduction with compact, shaft mounted units in a wide range of sizes and horsepowers are described by Dodge Mfg. Corp. in 64-pp Bulletin A692. Construction details, dimensions and installation information are given, illustrated with photos and engineering drawings, as well as tables designed to simplify selection of reducers for various applications, power requirements.

484 Speed Reducers — Catalog 590 is a 65-pp supplement to Ohio Gear Co.'s 186-pp general catalog on stock gears and speed reducers. It provides complete engineering data, dimensions and application selection charts on the Hi-Line series fin and fan cooled reducers. Catalog is pocket size, designed for convenient location of engineering data.

485 Flexible Couplings — Comprehensive selection data on flexible couplings is presented by Thomas Flexible Coupling Co. in 58-pp Engineering Catalog 60. Misalignment is described and basic coupling arrangements and load classifications are included, along with photos of couplings and installations, diagrams.

486 Eddy Current Coupling — Presented in 12-pp Bulletin GEA-6885 is extensive information on General Electric Co.'s Kinatrol line of eddy current coupling adjustable speed drives for 5 to 100 hp. Describes operating principle and contains data on torque capabilities, regulation and operation of entire package drive, cross-sections, dimension charts, ratings.

487 Coupling Data — An integrated selection of product bulletins and data on couplings of Koppers Co., Inc., for a variety of industrial applications is presented in this handy ringbound notebook. The notebook contains sections on product literature, engineering data, instruction sheets, application data, and price lists. To all of these sections, additional material can be added as it becomes available.

Other Equipment

488 Struts, Snubbers — In eight-pp Catalog 229A Barco Mfg. Co. describes and illustrates ball-type flexible struts for structural applications and Vibrasnub hydraulic vibration snubbers. For each product line, catalog explains operation, provides specifications and illustrates engineering applications. Also discusses advantages of the flexible struts and includes design and installation notes.

489 Productive Purchasing — Application of analysis techniques to purchasing methods is detailed by General Electric Co. in 22-pp Bulletin GED-3877. Discusses value analysis — the systematic evaluation of functional value — and includes a checklist for evaluating equipment suppliers which can be used for appraisal of such added values as reliability, technical capabilities, after-sale service, availability, buying convenience, and sales assistance.

490 Engineering Data Tables — Bulletin 5311, released by Leslie Co., contains 12 pp of engineering data tables. Included are formulas for valve, sizing, properties of saturated steam, steam flow in pipes, steam pressure drop determination, oil flow and viscosity data, properties of gases and liquids, piping data and fixture water flow, conversion factors. Also provided is handy chart covering selection of piping and valve materials.

491 Cathodic Protection — Booklet describes corrosion control for buried or submerged piping, tanks, ships and similar structures. The company's consulting services, field surveys, design, installation and materials as well as general cathodic protection procedures are discussed in detail by Harco Corp.

492 Tube Fittings Finder — Bulletin 4306-B1 offers condensed information on selection of proper fittings for various service and installation requirements. Includes shape charts for six types of industrial tube fittings and illustrations of tube-working tools produced by Parker Fittings and Hose Div., Parker-Hannifin Corp.

493 Why Coil Freeze-Ups — Technical Bulletin T-503 of Sarco Co., Inc. explains why non-freeze air heating coils freeze. This bulletin discusses the factors leading to freeze-ups, provides a chart for determining the freezing danger point, and offers some practical hook-ups to overcome freezing conditions.

494 For Cleaner Furnace — The use and application of Oxi Crystals to keep furnaces and the fireside of boilers free of slag, encrusted carbon, soot and fire-scale is described in a recent pamphlet of Oxi-Kor Corp.

495 Product Guide — Product Guide B-5529, 24 pp of American-Standard, gives ratings for air conditioning and air handling equipment, fluid drives, heat exchangers, surface condensers, steel boilers and related industrial products.

496 A Look At Coal — Importance of coal to the national economy is the subject of this 12-pp booklet of Peabody Coal Co. Increased use of coal by the electric utility industry is covered, as well as the use of coal by-products.

497 Pulsating Panels — Detailed information on Gerotor May Corp.'s Pneu-Bin pulsating panels designed to feed stubborn material from bins and hoppers is presented in this handy literature folder. Includes dimensional and performance data, illustrations, and a flow stoppage report to be filled in.

498 Scale Model Components — Vessels, heat exchangers and pumps of molded expandable polystyrene — model equipment which can be worked with knife or hand saw and can be sanded, glued, pinned or screwed — are featured in this 8-pp bulletin of Industrial Models, Inc. Piping system and structural components are listed.

499 Pump and Heater Sets — Bulletin 15, Walter H. Eagan Co., Inc. describes packaged fuel oil pump and heater sets designed for accurate control of temperature and pressure of heavy oils to insure proper atomization and combustion. Features are described and data presented.

Postage-free Reader Service Cards are on pages 109 and 110

THE LONERGAN LINE

HOW TO MAKE A GOOD IDEA BETTER

by Norman J. Smith

In this hurry-up age of missiles and electronics, it is often possible to overlook the fact that because a device or an idea is new, it is not necessarily the best.

For example, while there are many temperature and pressure sensing devices, none

has such universal application as the Bourdon tube, which was first conceived in 1849 by a French engineer, Eugene Bourdon.

Today, a modern "C" type Bourdon tube gauge, such as the Lonergan Maximon makes full use of Bourdon's original idea. At the same time, it utilizes the finest materials such as K Monel stainless steel, beryllium, copper and many, many others in order to improve Bourdon's basic invention. Other improvements are: twisted spiral tubes to measure the output of pressure transducers; long helical tubes with heavy walls to measure pressures up to 100,000 psi; and small tightly coiled tubes for movementless gauges.

While the power plant man with a gauge problem isn't concerned with all of these forms, it is interesting to note that in his application for a patent more than a hundred years ago, Bourdon anticipated all of these present day variations. He claimed application on all forms of curved or twisted tubes whose transverse sections differed from circular forms for temperature and pressure measuring, indicating and controlling of fluids.

The Lonergan gauge today incorporates all of the known advances in the Bourdon tube in any one of three lines. For applications requiring the finest gauge available anywhere, the Lonergan Maximon is the choice.

Get a full description of the complete line of Lonergan gauges in catalog 1000-G. Write for your copy today.

Norman J. Smith

Chief Engineer, Instrument Division

Lonergan

J. E. LONERGAN CO., 207 RACE STREET
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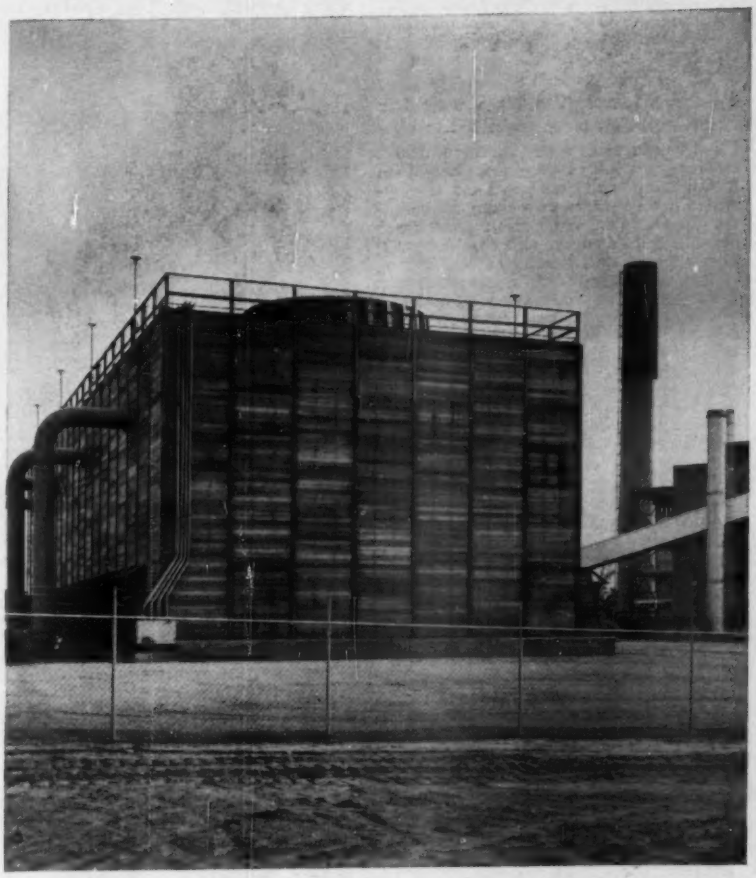
For more data circle 552 on Post Card

CORROSION COSTS CAN BE LOWERED



No matter how you figure it—in terms of replacement costs, treatment costs or higher production—Hagan can save you money by keeping cooling and service water systems at top efficiency. Complete treatment recommendations, based on experience with water problems in every kind of industry, are backed up by continuing service after treatment is started. Hagan's methods have achieved these results:

LOWER CHEMICAL COSTS: In most systems, treatment is more effective. This means that smaller amounts of chemicals can be used.

LOWER WATER COSTS: With more effective treatment, it is frequently possible to maintain higher solid concentrations in cooling water. This means less makeup water, and consequent savings in overall water costs.

BETTER RESULTS: In many plants, Hagan methods have reduced corrosion rates to 1 mil per year or less. At the same time, troublesome deposits were eliminated, increasing equipment efficiency, and overall chemical costs were lowered.

A letter or phone call will put Hagan Engineers to work on your particular water problem.

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HAGAN CENTER, PITTSBURGH 30, PA.

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Equipment News

Described on these pages are new and improved products. Use Reader Service Cards on pages 109–110 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—Rectifier conversion unit for electrostatic precipitators

Buell Engineering Co., Inc. announces a conversion unit comprising a silicon rectifier especially designed for electrostatic precipitators now using mechanical types. The conversion unit costs about a third as much as a complete new power pack, and it utilizes all existing equipment except for rectifier motor, disc, shoes, suppressor elements and pedestal. It ties in with present a-c connections, and also with the d-c switchgear which distributes the rectified power. Electrical efficiency is reportedly about 25 per cent greater than the mechanical type. Complete replacement takes 6 to 8 manhours; all parts of old and new rectifiers can be handled by one man, and without rigging. The new rectifier is made up of four independent units, and has a choke in the output line to protect rectifier from high voltage

feedbacks. Each unit comprises two racks of silicone diodes immersed in an insulated container of dielectric fluid. This conversion rectifier can also be used as a replacement for the electronic tube type rectifiers.

2—Telemetering system costs less, takes up less space

General Electric Co. announces a high-accuracy, transistor telemetering system priced about 35 per cent below company's other equipments. The system can be used to telemeter watts, volts, amperes and vars to a central location from remote sensors, and is adaptable to transmission of any quantity that can be converted to a d-c millivolt signal. It also features a package design that reduces rack space requirements, and use of plug-in modular units that contribute to easy maintenance and quick change-over of input, output and carrier frequency ratings. Low cost of the equipment, with rated accuracy given as ± 1 per cent, is attributed to a high degree of standardization throughout the many ratings offered, and use of transistorized circuits. The transmitter uses about a third the rack space of many models — in a standard 19-in. rack, its vertical dimension is 3½ in. Rack dimensions of the receiver component are claimed to be reduced nearly 80 per cent. Two can be placed side-by-side in a standard rack, requiring only 3½ in. vertically.

The basic system has a frequency rating of either 5–15 or 6–27 cycles per second. Converting to audio-tone frequencies is done by inserting transistorized circuit boards into transmitter and receiver via plug-in connections. Company plans to offer 24-hr shipment on both basic systems and a selection of plug-in range units. While d-c millivolt signals are the standard input, the system can, by a change of resistor units, be adapted to accommodate many ranges of d-c volt or milliampere signals. The receiver can operate indicators, potentiometric recorders, and other end devices. Current output normally ranges from zero to 1 ma d-c.

3—Analog computer kit teaches basic computing principles

For the training of industrial personnel, this unit demonstrates basic analog computing principles and can be used for multiplication, division, powers and roots, log operations, trig problems, physics formulas, electricity, geometry, etc. The easily operated computer is assembled with screwdriver and pliers and operates on two flashlight batteries. Three potentiometers and an electric meter are mounted on the die-cut box. To operate, two of the potentiometers are rotated and set at appropriate num-

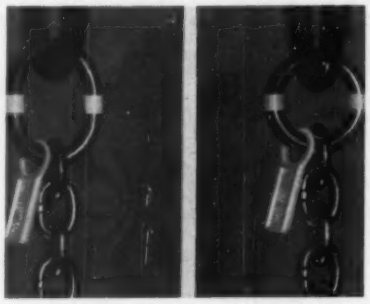
bers. The third is then rotated until the dial reads 0. Position of that dial then indicates the answer. The computer is 20 in. long, costs around $15.00, is a product of Edmund Scientific Co.

4—Top entry ball valves with socket weld connections

New additions to the McCannaseal line of Hills-McCanna Co. are top-entry ball valves with socket weld connections in 1, 1½, 2 and 3 in. This design lets the valve body be permanently welded into the pipeline. Access to valve parts is provided by a removable bonnet and stem assembly. Socket dimensions are made to American Standard Steel Socket-Weld Fittings Schedule 40. Body materials are carbon steel or stainless 316. Seats are Teflon or Buna-N. These valves feature self-adjusting ball seals and double back seated stem seals. They are designed for controlling gases, liquids, slurries, semisolids, difficult to handle and corrosive chemicals from −100 to 350 F. Maximum pressure is 700 psig, depending on temperature.

5—Sling chains show when they're overloaded

Sentry Slings, introduced by The Campbell Chain Co., incorporate a warning ring to provide visual evidence of overload. The warning ring elongates when the sling is overloaded, manufacturer states, and though stronger than the chain itself, this ring gives immediate warning by changing shape — before



permanent damage occurs. Warning rings can be replaced at the factory, it is noted, and in most cases only the ring need be replaced, minimizing repair costs. Sentry Slings come in many types, are made from Cam-Alloy steel chain. Chain at left of photo shows ring distorted from overload. In the chain at right of photo, the ring remains round in shape because the sling has been properly loaded.

6—Extended-arm limit switch comes in two forms

Designed to simplify installation at hard-to-reach locations on general machinery and conveyor systems, the CR9440 J1 of General Electric Co. is available with two extension forms; an adjustable radius roller lever and an ex-

MODERN DESIGNS FOR POWER...BY KULJIAN

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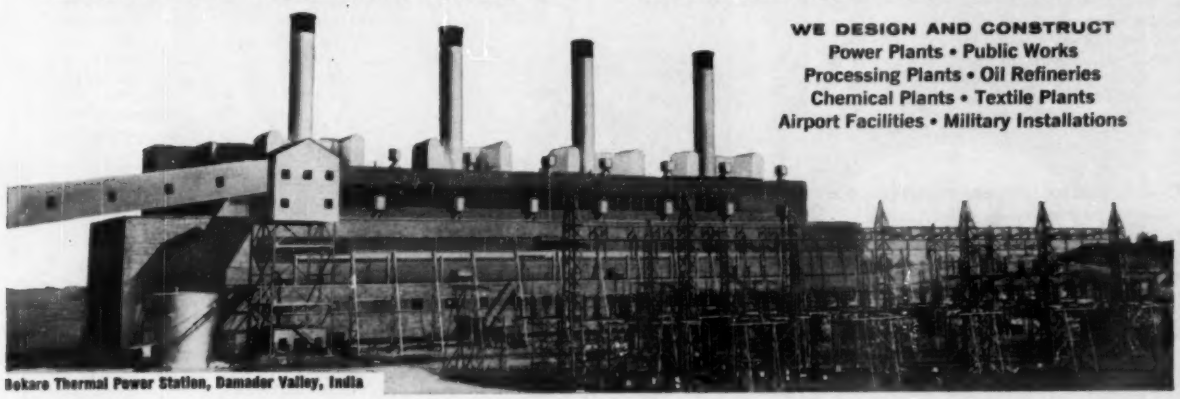

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For example, all Fast's Couplings are jig-drilled and jig-reamed for greater interchangeability of parts. Result: you get high-quality, smooth-running, long-lived units that are the choice of more equipment manufacturers than any other gear-type coupling.

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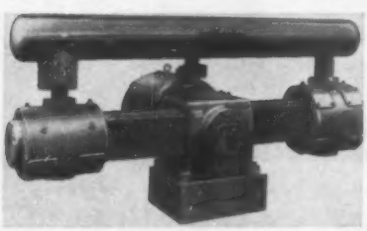
tended arm lever. For use when a limit switch cannot be mounted closely to the part to be detected, the adjustable-radius roller device can be used in conveyor applications where the parts to be detected must not be marred. The arm may be actuated between 2½ and 5-in. from the switch. The extended rod lever switch has an operating radius of 10¾ in. permitting actuation up to that distance from the switch. Since location does not have to be as precise as with a normal limit switch, the installation of the extended arm limit switch is simplified. Allen screw and spine adjustment is tolerated and movement up to 55 fpm is permitted with both forms.

7—Non-lube air compressor for heavy duty applications

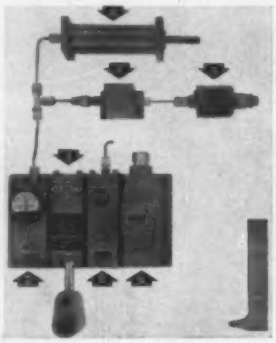
Designed by Clark Bros Co. for continuous heavy-duty service in applications where lube oil contamination of the air stream cannot be tolerated is the Model ICA, a balanced/opposed type compressor driven by a flange mounted electric motor. Piston rings and rod packing are self-lubricating Teflon. Manufacturer points out that Teflon, because of its toughness, will not break under normal handling. The non-lube cylinder is connected to the crankcase



by an extra long distance piece, internally divided into two compartments by a baffle plate which houses oil scraper piston rod packing. This arrangement isolates the compressor cylinder from the main compressor lubrication system. To further prevent lube oil contamination of compressor piston rod and piston rod pressure packing, an oil slinger is placed on the rod between oil scraper packing and pressure packing. The rod is chrome plated to eliminate possibility of corrosion from cooling water passed through pressure packing and circulated around rod surface. Model ICA is a 6-in. stroke machine built in four sizes rated from 75 to 150 bhp.

9—Self-powered engine control protects against overspeed

The Calcon Safety Control System is described by California Controls Co. as the first non-electric, self-powered system to protect all types of engine installations against overspeed. Operated through a small captive charge of compressed air, the system requires no



batteries or other electrical supplies. According to company, this control system can put into operation almost any type of pilot operated valve, switch, warning or other device when the captive air charge is dumped to atmosphere by sensing units. The system utilizes modular standard components combined to meet installation requirements. Equipment required for a typical engine installation is shown in the photo of the Model 490 kit. Elements are: (1) hand charging unit; (2) pressure sensing unit with charge air gage; (3) coolant temperature sensing unit; (4) overspeed sensing unit; (5) lube oil pressure sensing unit; (6) actuating unit. Lube oil and overspeed sensing units have built-in trouble indicators, while temperature unit has an auxiliary indicator (7).

10—Steam converter for heating radiation water

Among advantages claimed by Dunham-Bush, Inc., for the SC Steam Converter are simplified piping and reduced design work. Used primarily for heating radiation water with steam, the SC is said to be highly efficient for providing heating water for office space in industrial buildings. When applied to high buildings, it is said to keep static heads at reasonable levels, simplify piping.

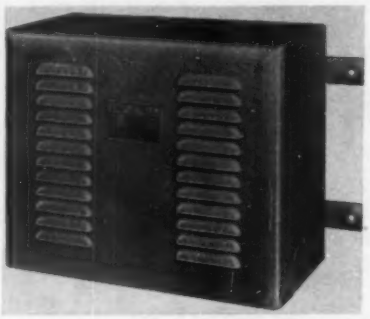
11—Liquid level control stands vibration and corrosion

Designed by Magnetrol, Inc., to provide liquid level control in most locations where vibration and corrosion are serious problems, Model 752 Magnetrol is a single-stage, external float cage style control. It can be electrically or pneumatically switch operated. A new electric switch mechanism (the S-6) for this control is magnet-actuated, two-position, snap-action mercury switch, to eliminate splashing of mercury across the contacts under severe vibration. The rocker arm dual magnet action allows holding action in either switch-actuating position.

For applications where pneumatic switch operation is required this control can be equipped with a non-bleed, pneumatic switch mechanism (the J-2). It is a magnet-actuated, two-position, snap-action pneumatic switch designed not only to provide positive snap action for both "on" and "off" positions, but also to utilize magnetic force to hold the air valve position despite severe vibration. Model 752 features construction materials designed to resist corrosion, has an explosion-proof/vapor-proof switch housing. Twelve float chambers are available for the controller.

12—Multi-motor converter for single-phase lines

Type MM Add-A-Phase Power Converter permits operation of three-phase electrical equipment from single phase lines, but with the additional feature of opening operation to any number of three-phase motors through a single conversion system. Three-phase motors



can be operated singly or simultaneously. Multi-motor transformer stations are available in sizes from 1 to 80 hp. Panel controls feature separate hp ratings to match each three-phase motor. Converter is designed by Add-A-Phase, Div., System Analyzer Corp. to operate 220 or 440-v three-phase equipment from 220 single-phase lines.

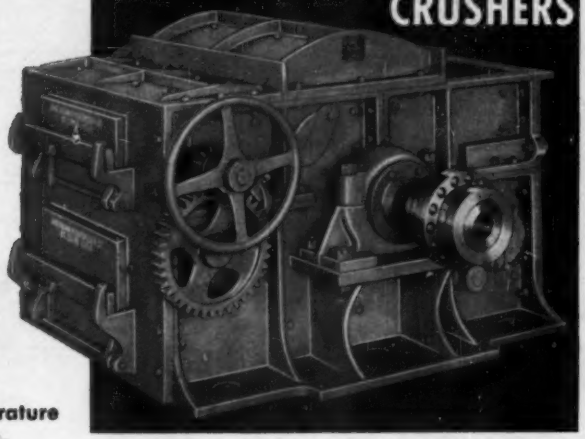
13—Furnace refractory is strong and light in weight

Franco Lite 30, weighing only 31 lb per cubic foot, is reported to show no linear change or shrinkage from a cast to a dry state. It is a development of J. H. France Refractories Co. to meet the need for a lightweight and good strength backup insulation for industrial furnace use. Features announced are high coverage capacity, workability, lower thermal conductivity. The material is supplied dry and claimed as easy to mix as refractory castables or regular concrete. It

8—Industrial fencing made of glass rovings and resins

Firm-A-Line Fencing is described by Crompton & Knowles as a corrosion resistant, non-conductive, fire retardant fencing composed of continuous strands of glass rovings and polyester resins. According to manufacturer, this lightweight fencing is both long lasting and strong; it is rat-proof and has no moisture pick-up, and it does not require paint. Standard thickness is ⅜ in. on 1-in. center. Standard size is 30-by-80 in., weight is ¼ lb per square foot, and fiber glass tensile strength is 125,000 psi. Pigmented resins make possible many color variations and can provide safety colors and color coding. The fencing can be cut with tinsnips, hacksaw and hand-powered tools. In addition to use as fencing or protective screening in corrosive atmospheres, Firm-A-Line Fencing is also suggested for machine and acid bath guards and fencing around electrical installations.

AMERICAN AC ROLLING RING COAL CRUSHERS



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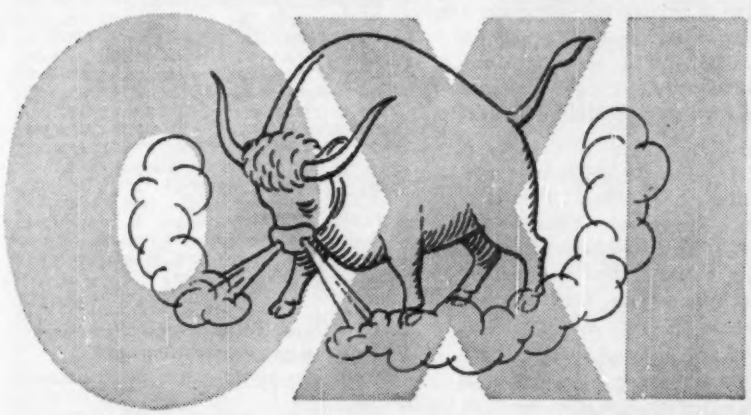

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OXI Crystals increase boiler efficiency by getting rid of slag, firescale, encrusted carbon and soot *fast*. OXI oxidizes combustible deposits from firedoor to stack top. Get more heat and steam at less cost...write for complete information today! No obligation, of course.

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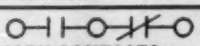

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SEQUENCE OPTION after installation by means of independent slide switch at each point.

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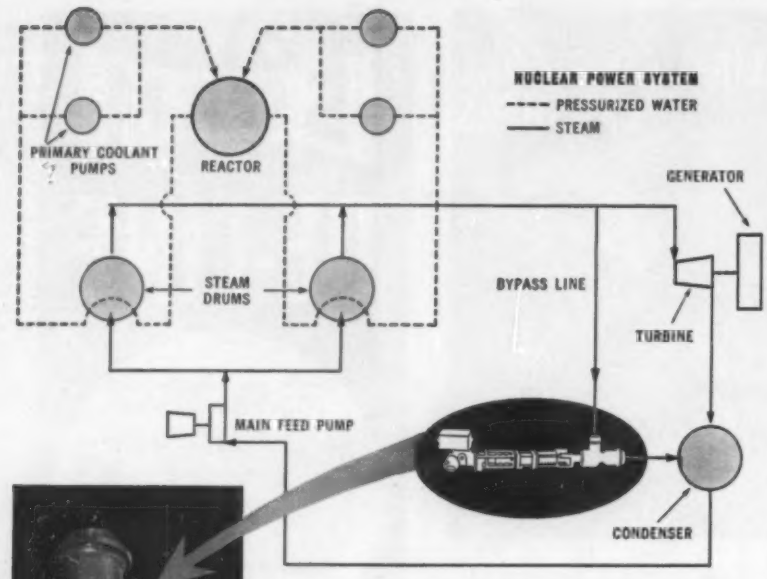

SK Reducing or "Transition" Valve. Because its application is critical, this valve has two methods of automatic control—motor and hydraulic cylinder.

For a critical nuclear use AN SK "NUCLEAR-QUALITY" VALVE

The diagram is typical of several systems now in actual operation. The valve is typical of "nuclear-quality" supplied by SK for critical applications.

It is located in a bypass line between a nuclear reactor and condenser. When steam pressure increases beyond the capacity of the turbine, the valve automatically bypasses the excess steam directly into the condenser.

The application *is* critical. The valve *is* right for the job. It should be. It was subjected to a "Helium Leak Test." The body was radiographic inspected. Flanges are Sarlun type, seal-welded to prevent leakage. The valve stem stuffing box is specially sealed for radioactive service. And, all components were made to exact specifications.

In other words—it was made by SK valve experts and checked by SK quality-control specialists. It's a valve that's *right* for the job.

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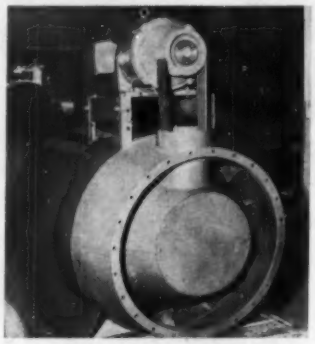
has a cold crushing strength of 630 psi, manufacturer states, and 1 in. of Franco Lite Cast 30 is equivalent to 7 in. of firebrick as an insulating material.

14—Centrifugal fan requires less installation space

Centriline, a straight-line flow centrifugal fan, introduced by Sturtevant Div., Westinghouse Electric Corp., is designed to enable air conditioning and air handling fan installations in less than half the space previously required. It enables use of small areas in industrial and commercial buildings formerly considered "waste" space, manufacturer points out. You can hang the compact fans



from the ceiling, mount them on the wall or stack them one above the other. Size of the Centriline ranges up to 50 per cent less than conventional scroll-type units, achieved by shaping the housing to provide "straight-through" air flow rather than right-angle flow.

High efficiency is attributed to use of the airfoil-bladed centrifugal wheel which lets air follow blade contours closely and also serves to prevent noise-producing turbulence on upper blade surfaces. Rated according to AMCA classifications as conventional scroll-shaped centrifugal fans, the Centriline comes in six sizes with airfoil wheels from 27 to 44½ in. diam. The welded steel case is braced internally to carry the weight of motors and allows for two mounting methods: with motor base on the fan housing (as shown) and with motor mounted on an integral vibration base. Both arrangements are V-belt driven. Volumes range from 4700 to 46,800 cfm. Installation is simplified because inlet and outlet dimensions are the same, and one size duct may be used. Catalog 1125 gives data.

15—Centrifugal pumps for sewage, waste disposal

These vertical centrifugal pumps, made by Walter H. Eagan Co., Inc. for disposal of raw sewage, industrial waste, solids in liquid suspension, etc., come in capacities from 50 to 600 gpm. Features announced include screenless operation with non-clogging impellers that can handle large solids and stringy material; heavy duty sealed ball thrust bearings independent of motor bearings; adjustment for raising or lowering shaft; and tongue and groove shaft column connections. Models have discharge heads to 75 ft and are available in a suspended pump type for pit depths to 17 ft, and submersible pumps for excessively deep settings and noiseless operation. Bronze and stainless steel construction can be furnished for operation in corrosive

ENCO
TYPE E REGISTER

FOR OIL and/or GAS FIRING

Saves Money and Troubles in 5 Ways

Details of the ingenious features that assure these results are available in literature — gladly supplied whether you contemplate buying or just want to keep up-to-date on this subject.

EC314

THE ENGINEER COMPANY
75 WEST STREET, NEW YORK 6, N. Y.

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More equipment manufacturers choose Fast's Couplings than any other gear-type coupling

Leaving other claims aside, the thing that counts in couplings is customer confidence —and industrial equipment manufacturers have made Fast's their overwhelming choice. The Fast's line is more diversified, too—in a complete range of sizes and types for shafts, from ½" to 32" and larger.

Every Fast's Coupling brings you superb engineering only the original gear-type coupling can deliver. Smooth-running units that are designed to outlast the machines they connect. Rapid service from experienced field engineers backed by outstanding stock facilities. Write today for full details on couplings to suit your needs to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 1211 Scott St., Baltimore 3, Maryland.

KOPPERS

FAST'S COUPLINGS
Engineered Products Sold with Service

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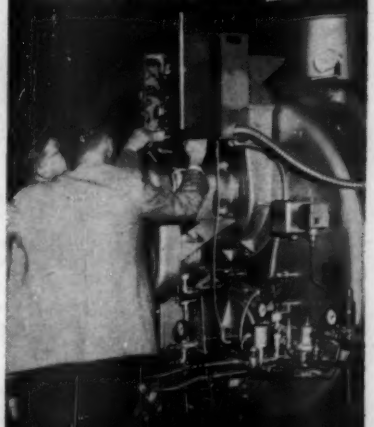
CONSIDER YOUR FUTURE IN

POWER GENERATION



Transformer capacities up to 400,000 KVA . . . Nuclear Reactors . . . Once-Through Boilers to handle higher pressures—all point to one thing: the demand for even better power equipment. Record economic forecasts mean even greater responsibilities and demands on the men who will grow with the power boom.

Keeping up-to-date with the latest developments provides you with the information you need to know to grow. That's why the Power Show is so vitally important to you. There you will see up-to-the-minute developments in hundreds of power specialties widely used in the power industry.

Only at the Show will you have the opportunity to investigate, compare, and get the right answers, face-to-face, from the manufacturers themselves. At the Power Show you'll see more than 250 suppliers' products, all conveniently grouped together.

Make sure you're there. Everyone else will be!

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NEW YORK COLISEUM
NOV. 28—DEC. 2, 1960

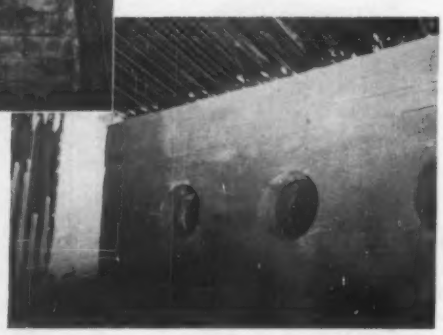
MANAGEMENT: INTERNATIONAL EXPOSITION COMPANY
480 Lexington Ave., New York 17, N. Y.

FURNACE BLOK* "IN"

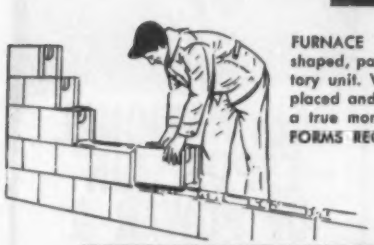
AT LARGE EASTERN UTILITY OIL-FIRED BOILERS

Nine months ago, a large eastern utility *replaced firebrick* with FURNACE BLOK in the burner and target walls of oil-fired boilers. As a result of drastically lower erection costs and excellent service life, utility will now standardize on FURNACE BLOK in these walls.

Target wall, 20 ft. high x 26 ft. wide, of oil-fired boiler. FURNACE BLOK washcoated with Super #3000 Refractory Mortar. After nine months' service, washcoat brushmarks still visible.



Burner wall, 8 ft. high x 26 ft. wide, of oil-fired boiler showing perfect condition after nine months' service.



FURNACE BLOK is a specially shaped, patented, hollow refractory unit. When BLOK units are placed and filled, they produce a true monolithic structure. NO FORMS REQUIRED.

FURNACE BLOK INFORMATION KIT
Contains Technical information, installation photos, cost comparisons and prices. Write today.

*U.S. Patent No. 183597

R&I

REFRACTORY & INSULATION CORP.
130 WALL STREET • NEW YORK 5, N.Y.
Sales Offices: Chicago, Ill.; Cleveland, Ohio; Bryn Mawr, Pa.; Newark, N. J.; Buffalo, N. Y.

Manufacturers of | Castable and Bonding Refractories; FURNACE BLOK; Blankets, Block, Plastic and Fill Insulations.

For more data circle 563 on Post Card

liquids. Pumps are offered in single or duplex arrangements — single for secondary service, and duplex if continuous service is critical.

16—Chemical feeder handles powders, granules or lumps

Type G feeder is designed by Infilco Inc. to handle all dry chemicals normally used in water and waste treatment, whether chemicals are in powder, gran-

ule or lump form up to ¾ in. diam. Finely balanced weighing mechanism gives an accuracy of ± 1 per cent, company says, of the set rate over an operating range of 20:1. Feeder is housed in dust-tight enclosure, with electrical and operating controls an integral part of unit, but separated from feeding mechanism by dust-tight partition. Agitators within hopper are made to prevent arching or "hold-up" of chemicals.

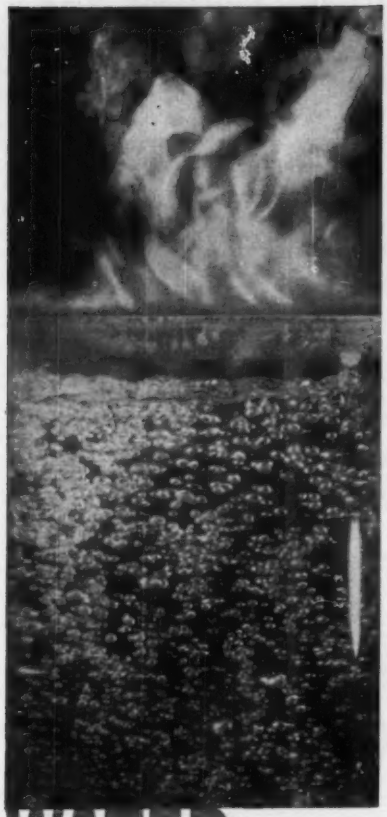
17—Portable sandblaster for fast, economical blasting

Developed by Hamill Mfg. Co., the Handi-Blast Portable Sandblaster is said to require no more air than a production spray gun. Overall height of the unit is 23 in.; it has a tank diameter of 7 in. It weighs 23 lb empty and has an abrasive capacity of 30 lb sand. Air supply of the

unit is consumed at the rate of about 8 cfm, using the furnished $\frac{5}{32}$-in. nozzle and air supply from a 2 hp compressor. A $\frac{3}{32}$-in. nozzle, also furnished, consumes about 20 cfm, requiring an air supply from a 5-hp compressor. Tested at 300 psi, the Handi-Blast Portable Sandblaster operates with abrasives between 20- and 100-lb mesh. It costs around $100.00. Form HB5360 gives details.

18—Single-stage centrifugal pumps require less space

Reduced space requirements make the OJV and OMV Vertical Split Case Pumps suited to applications requiring extreme compactness. The case is split parallel with impeller shaft, with suction and discharge flanges integral in the vertical base section. Rotating unit is removable for inspection or maintenance without disturbing suction or discharge piping connections. Pump is designed by Aurora Pump Div., The New York Air



WATER
FOR BOILERS
NEEDS
DEOXY-SOL

- to remove O_2
- reduce oxides
- raise pH

Fairmount DEOXY-SOL, a solution of hydrazine, is a high efficiency oxygen scavenger designed especially for high pressure boiler water treatment.

DEOXY-SOL removes oxygen, reduces oxides and raises pH of the condensate all at the same time . . . yet adds no solids.

Stocks in Newark, N. J., Chicago, Ill., Los Angeles, Calif. Investigate its advantages for your system. Write for Bulletin PE.

Fairmount
CHEMICAL CO., INC.
136 Liberty St. New York 6, N. Y.

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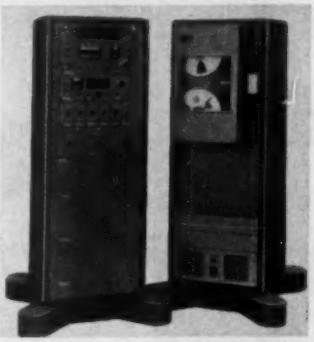
Brake Co., for handling high capacities at medium to high heads and continuous operations in municipal water service, industrial water service, booster service, cooling towers, fuel service, circulating and boiler feed. Capacities range to 6000 gpm and heads to 380 ft.

19—Data processor features versatile format control

The EI Model 10000 is announced by Electro Instruments, Inc., as a low cost, high speed, low level differential data acquisition system with versatile format control which produces data acceptable to most computers. Its modular design makes possible acceptance of all types of electrical signals representing variables being measured. Basic system consists of three components — high speed scanner in 10 channel multiples, high speed analog-to-digital converter, and output format control.



Typical inputs which may be directly connected are thermocouples, strain gages, pressure, flow and level transducers, and analyzers of both quantitative and qualitative types. All parameters of electrical quantities may be measured by addition of appropriate modular equipment. Format control receives digital information from analog-to-digital converter or external channels, from clocks and electronic counters. It converts digital input information to required format for magnetic tape programming and computer entry, also provides systems programming, outputs for operating accessory print-out devices, digital readout for visual presentation of data during recording and tape play back.

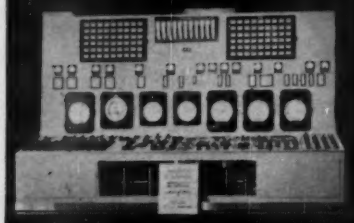
20—Power-generating set for quick emergency power

Announced by Fairbanks, Morse & Co. are diesel power-generating sets capable of delivering a full load of electric power within 8 to 30 sec after starting from a dead stop. Six engines have been developed, capable of supplying 12,000 kw of power, at 16,800 hp. The engines with their quick-starting feature are believed to show particular promise as power sources that can augment normal power flow at peak-use periods of the day, or as stand-by units for emergencies.

21—Spring-loaded seal utilizes self-conforming polymer

This spring-loaded self-conforming polymer seal, made by Del Mfg. for applications in reciprocating and low-speed rotary shafts under high pressure liquid

WHAT COMES UNDER
ENERGY
CONTROL?



On paper it's just a phrase, but at work with you and your company it's important. Everything from fuel savings to calculating nuclear fuel costs comes under the heading of "energy control"—a subject of profit to you and your company.

Constant changes in the field make it imperative that you see such exhibits at the Power Show as temperature controllers, pressure and draft controls, liquid heat controllers and many others —PLUS a broad line of other power and allied equipment.

Only at the Power Show do you have the opportunity to investigate, compare and get the right answers, face-to-face, from the manufacturers themselves. Only at the Power Show can you see over 250 leading suppliers' products, all conveniently grouped together at one time.

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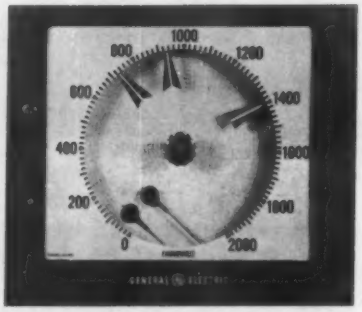
and gas conditions, combines polymer and spring steel in a principle designed to insure efficient operation over range of −320 to 500 F and under pressure to 10,000 psi. Seated around a shaft, the seal sets up a load toward the shaft, its polymer gasket deforming under constant pressure to produce gas-tight seal. Device is engineered so polymer deformation is always toward shaft and self-adjusting to creep and wear.

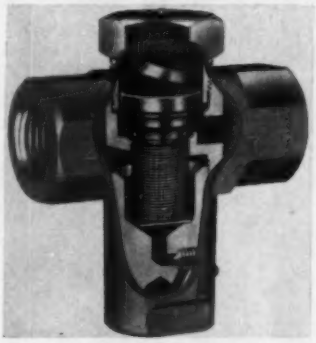
22—Two-pen recorder for two variables on single chart

This two-pen potentiometric round-chart recorder-controller is designed by General Electric Co. for nearly any application where two variables must be recorded on a single chart. Measurement circuits may be either potentiometric or bridge-type, or combination of both. Zener diodes offer a constant voltage reference accurate to ± 0.05 percent, company says, and temperature coefficient s 0.001 percent per degree Centigrade. Minimum scale spans are one millivolt d-c. Pen speeds are 4, 10 and 24 sec full scale, and chart speeds are 1, 8, 12 or 24 hrs; or seven days. Adaptable for surface or semi-flush mounting, unit is 19 in. wide, 16 9/16 in. long, 15 7/8 in. deep.



23—Impulse steam trap for light condensate service

Strainer and blowdown valve are combined in one body in the Yarway No. 130 Impulse Steam Trap. Designed by Yarnall-Waring Co. for light condensate loads with steam pressures from 8 to 600 psi, this trap requires only two connections. Manufacturer states that by eliminating separate strainer and blowdown valve and their necessary fittings, it offers potential installation savings of up to 30 per cent, reducing pipe connections by as many as six. The trap employs the thermodynamic principle of steam trapping in which the valve disc snaps open to discharge condensate but closes on steam. It is furnished with ½-in. pipe connection. This design places the blowdown valve ahead of the strainer screen and trap. Opened and closed by an Allen wrench, the slowdown valve has a threaded outlet for applications where it may be desirable to pipe blowoff away from the immediate area. Company recommends this trap for steam main drips, steam tracer lines, and other similar light condensate installations. It is expected to prove most advantageous for new equipment where it simplifiies piping and reduces installation costs.



24—Intake units replace air removed by exhaust systems

Vertical discharge air intake units — for use in replacing air removed by exhaust systems — have a capacity range of 4000 to 36000 cfm. They are manufactured by Hartzell Propeller Fan Co. Key to versatility of the line is assembly to meet job requirements of standard components. Shutters, steam coil, filter house and outlet diffusers are added as needed to the basic low silhouette, block-out type roof ventilator fan housing. Where tempered air is required and a steam coil used, Btu capacity (at 5 lb steam pressure) ranges from 380,000 to 2,642,000 Btu/hr.

25—D-c motors and generators are totally enclosed units

Announced by Westinghouse Electric Corp. are totally enclosed d-c motors and generators designed for both constant speed drives and drives involving

FORCED DRAFT—REGISTER TYPE PACKAGED BURNER SYSTEM

FULLY AUTOMATIC OR SEMI-AUTOMATIC . . . this high efficiency system is manufactured in a wide variety of sizes and models, arranged for firing steam boilers and high temperature hot water generators of all types up to the equivalent of 100,000 lbs. of steam per hour. Available with axial flow blowers or centrifugal blowers fitted with electric motor or steam turbine drive as required.

"SAV-PAC" is built for trouble-free performance, extra economy using all grades of fuel oils, gaseous fuels or combinations of both. Self-contained unit includes register-type burner, forced draft fan, air-fuel controls, wiring and piping in separate enclosed panels, mounted complete.

Also available TODD ROTO-PAC *fully automatic forced draft rotary burner systems.*

Write for complete details and specifications

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PRODUCTS DIVISION

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fast, wide speed changes and reversals, automatic control, or close regulation. The line includes fan-cooled and non-ventilated machines in both industrial and explosion-proof construction. Motors are rated from ½ to 60 hp at 300 to 3500 rpm; generators, from ¾ to 40 kw at 850 to 3450 rpm. Major departures

from conventional design noted are: use of a high-temperature silicone insulation system for machines rated and built for continuous operation with a temperature rise of only 75 C (NEMA's new Class B standard for totally enclosed machines), and application of a new high-capacity system of controlled ventilation in which blowers and heat exchangers are mounted at the shaft end. Principal advantages claimed are faster response, stability and increased insulation life. Armature inertia has been decreased 75 per cent, company states; and field time constant (electrical inertia important to generator response), by 35 per cent.

26—Machinery mount isolates horizontal motion

Series RM is a horizontal force mount offered by Barry Wright Corp. for isolation of shock and vibration produced by horizontal compressors and other machines whose operation develops predominantly horizontal forces. Each mount is designed to handle up to 4000 lb of static load; one is used under each machine foot or support point and all are positioned for cushioning in the direction of horizontal forces. The equipment rests on a top plate that rides on a set of internal rollers and is laterally restrained by end-positioned Neoprene springs, available in various stiffnesses

to permit selection of spring-rate suited to forces and frequencies involved. The Series RM is 10⅝ in. by 8 in. overall, and 1¾ in. high; it is furnished with attachment bolt and locknut. Company

DON'T OVERLOOK

STEAM SPECIALTIES

If you believe that it's often the little things that count, you will pay attention to such items as steam specialties. Often-used in large volume, their performance can contribute substantially to profit or loss in your company's operations.

You will see at the Power Show such steam specialties as steam traps, strainers and separators, steam cleaners, controllers and regulators, temperature and pressure instruments, indicating and recording devices, as well as a complete range of power and allied equipment ready for your inspection.

Here is your opportunity to investigate, compare, and get the right answers, face-to-face, from the manufacturers themselves. Only at the Power Show can you see over 250 leading suppliers' products, all conveniently grouped together.

It's important to your job to be there.

2524

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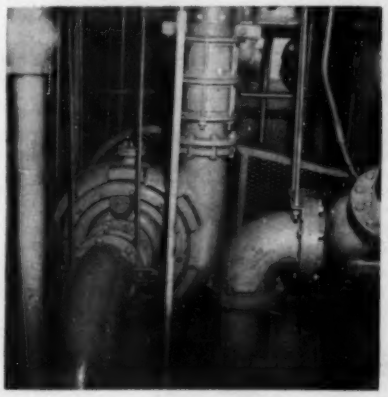
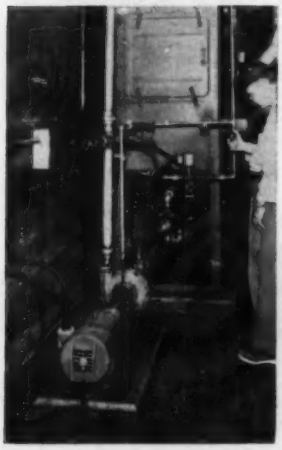
YOU CAN HANDLE

- FLY ASH
- WETTED COAL DUST
- GRITTY DRAINAGE

economically with

Nagle Pumps





They are designed specifically to pump highly abrasive solutions or slurries. Nagle "K" series pumps are shown—one of two 6" type "KR" pumps handling fly ash from wet bottom combustion chambers at Town of Hempstead, N. Y. Dept. of Sanitation and a 1" type "KC" pumping coal dust in water in basement of breaker structure at Gallatin Steam Plant of the T.V.A.

Tough jobs call for

Nagle PUMPS

FOR ABUSIVE APPLICATIONS EXCLUSIVELY

They feature simple, readily accessible stuffing box adjustment and easy slippage seal adjustment. Built for years of gruelling service.

Many power generating companies and others employing boilers, incinerators or furnaces, have had excellent performance from Nagle Ash Handling Pumps—both horizontal shaft and vertical shaft type. Send for Nagle Pump Selector. Nagle Pumps, Inc., 1229 Center Avenue, Chicago Heights, Ill.

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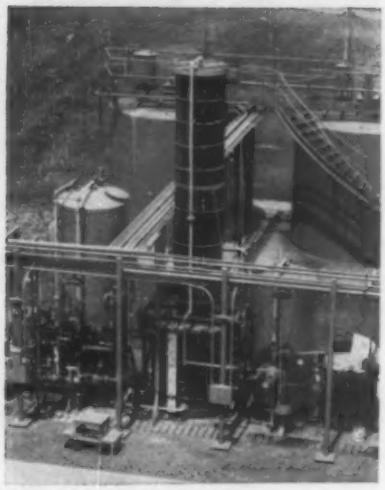
ILLCO-WAY

ionXchange



"SILICA: 0.003 PPM, OTHER SOLIDS UNMEASURABLE..."

With some doubt as to the outcome, the de-ionization units pictured above were installed outdoors at a Texas power and light company, to replace evaporation equipment as a means of purifying feed water for a high-pressure boiler. After three years, results far exceeded guarantee and expectations. From raw water containing 27 ppm of silica and dissolved solids totaling 365 ppm, the quality of the effluent is reported as: "Silica, zero to 0.005 ppm, average 0.003 ppm. Other solids are unmeasurable."—This is a good example of what modern ILLCO-WAY ionXchange can accomplish.

BOILER FEED WATER FOR POWER PLANT

The particular plant shown above consists of a cation exchanger, an aerator, and a mixed-bed deionizer. The large tanks in the background hold a supply of regenerants. Operation is manual throughout, a preference of the purchaser. *Results have proved even more economical than expected.*

ionXchange

ILLINOIS WATER TREATMENT CO.

ILLCO-WAY

840 CEDAR ST.
ROCKFORD,
ILLINOIS

NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

For more data circle 569 on Post Card

points out that with this mount, special foundations and grouting, or inertia blocks aren't required.

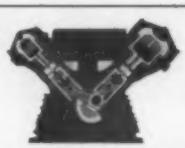
27—Platform ladder is a non-conductor of electricity

The Alco-Lite P400 Fiberglass Safety Platform Ladder is a non-conductor of electricity as well as being non-absorbent. It is designed by Aluminum Ladder Co. to provide maximum safety around high voltages and resist damaging effects of moisture, chemicals, acids, fumes, and gases. High tensile strength aluminum steps, platform and fittings are riveted to Fiberglas siderails. Steps and platform are of non-slip design. It is available in heights from 4 to 10 ft.

28—Strainers for lines carrying steam, water, gas, oil

Y-type tapered-seat strainers, announced by L-R-P Inc., are for pipe sizes ¼ to 3 in. and are reported effective in lines carrying steam, water, air, gas or oil.

They are designed to permit use of the full area of the strainer which is held by tapered seats at both ends. Tests show the strainers have no more resistance than an elbow, company states. The gasketed cap at bottom has a pocket for collection of foreign material which can easily be removed through the blow-off connection. Strainers are available in cast semi-steel, cast steel and cast bronze and can be installed in horizontal or a vertical down-flow line.

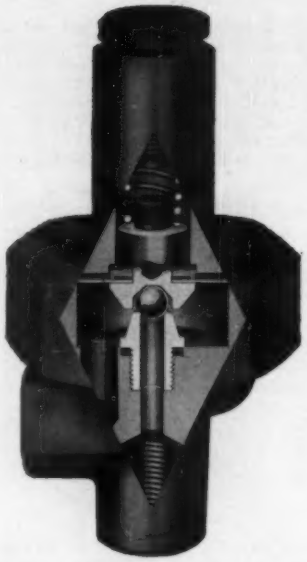


ANSWER

to Worthington Hidden Value Puzzle

The fictitious "hidden value" on the back cover is, of course, the "Articulated Connecting Rod." This design is found only on light duty compressors with single acting cylinders.

The true Worthington connecting rod construction is shown above. Each rod is directly mounted on the main crankshaft, giving greatest bearing area and stronger linkage. There are fewer parts in all, maintenance is simpler and lubrication is less complex. Worthington Corporation.



THIS PREMIUM RELIEF VALVE PROVIDES ABSOLUTE SAFETY IN CORROSIVE SERVICE

- The Milton Roy full-lift design assures immediate and positive relief when the set pressure is reached, yet there's no chattering or leakage as the relief valve approaches its set pressure.
- Continued leak-free operation is assured even after the valve has opened in corrosive service, because topworks are completely isolated from the process stream by a Teflon diaphragm.
- Wetted parts are available in steel, 316 stainless, Carpenter 20 stainless, Hastelloy "C" or "B", or PVC. Sizes range from ¼" up for pressures to 1500 psi. Back pressure valves are also available.

For complete information, request Bulletin 357-2 from Milton Roy Co., 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania.

milton Roy

CHEMICAL INSTRUMENTATION SYSTEMS

Controlled Volume Pumps • Quantichem Analyzers
Chemical Feed Systems • pH Instruments

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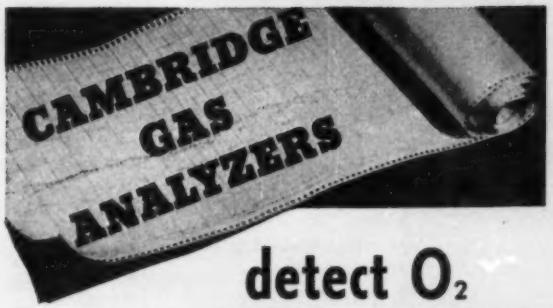

detect O_2 in FEED WATER

Continuous records of the oxygen dissolved in boiler feed water and of the hydrogen entrained in steam, indicate when corrective measures are necessary to prevent otherwise unsuspected and costly corrosion. Cambridge Analyzers measure and record dissolved oxygen directly. The hydrogen in the steam is measured and indicates the quantity of oxygen set free by dissociation. Cambridge Instruments are available for continuously recording either O_2 or H_2 separately, or O_2 and H_2 simultaneously.

Send for Bulletin 148 B. P.

CAMBRIDGE
INSTRUMENT CO., INC.
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YOUR RIGID
PIPELINE
CONNECTIONS

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ALLFLEX MNH
flexible pipe connectors
FROM STOCK
IN STAINLESS STEEL
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1

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to prevent costly corrosion and scale deposition...modern steam power plants rely upon *one* name...the *leader* in development and production of *advanced* pH instrumentation for 25 years **Beckman**

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Beckman pH sales and service is foremost in North America – 3 strategic parts locations – electrodes available from more than 100 scientific apparatus dealers – field engineering in over 300 branches of leading recorder companies. Write for Data File 78-11-06.

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2-
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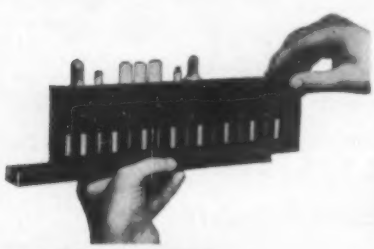

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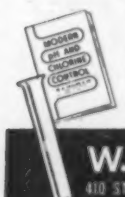

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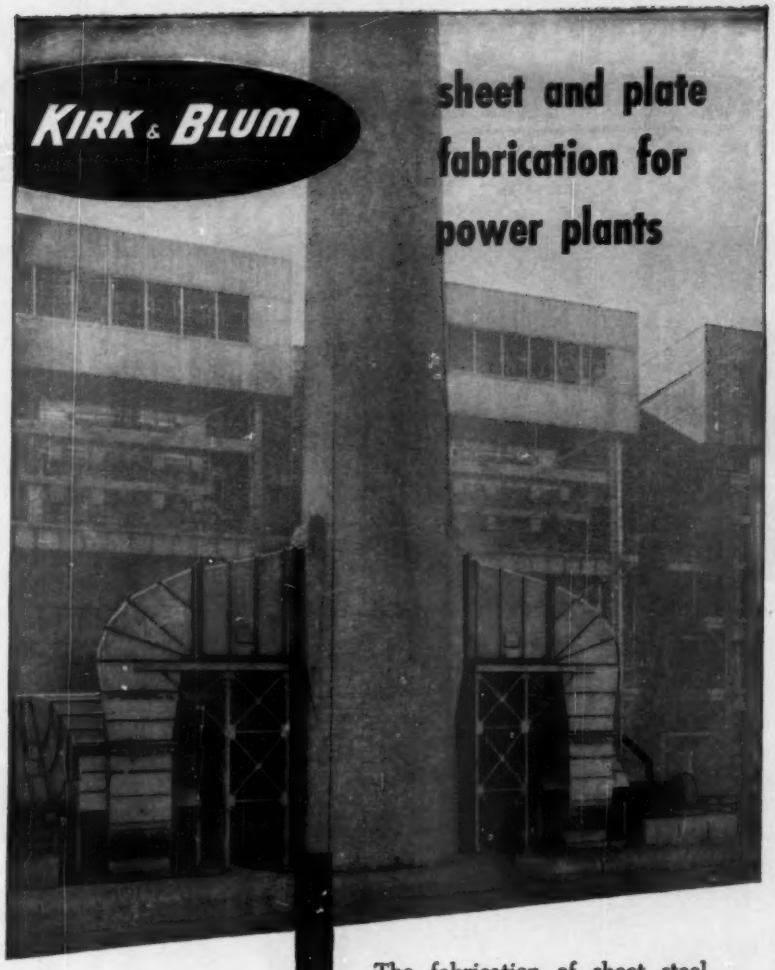

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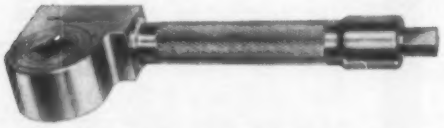
SUPER-POWERED
for super-fast cleaning of
BOILER TUBES

WILSON ECT TUBE CLEANERS

Wilson Model ECT super-powered air driven tube cleaners are designed to deliver maximum power at the most efficient cutter head speeds while negotiating sharp bends. They quickly, thoroughly clean curved boiler tubes from 2½" to 4½" O.D.

Wilson Model ECT air cleaners can be used with either SE or CHJ cutter heads or with the flexible brush holder and expanding brush shown.



Wilson right angle worm gear drive is designed for maximum duty and service life. It is excellent for operating tube expanders in the very confined areas of boiler headers. Bevel gear, gear train drives and universal extensions also available.

Wilson Model 38 Tube Expanders are self-feeding and parallel expanding. They are of the single flare roll type. Available for tubes 1" O.D. to 4½" O.D. with various roll lengths for tube seats ¾" and up.

Shown are just a few tools from Wilson's wide range line of efficient, economical tube cleaners and expanders.

Write for comprehensive Catalog 77-88.

TW900A

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WILSON

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Oxygen analyzers save fuel dollars from going up in smoke. Beckman Model F3 Oxygen Analyzers help assure maximum combustion efficiency by continuous, accurate flue gas readings... help maintain optimum oxygen/fuel ratios... eliminate wasted fuel, heat losses, excess smoke. In automatic, round-the-clock, severe service, the Beckman Model F3 provides simple, fast, accurate, directly linear measurements... assures maximum power for every fuel dollar. ⌘ Get pertinent facts from your Beckman Sales Office. Or write direct for Data File 78-11-08.

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Scientific and Process Instruments Division

Beckman Instruments, Inc.

Fullerton, California

INSTRUMENTAL IN YOUR FUTURE 25 YEARS 1935-1960

For more data circle 376 on Post Card

What's the reason? Why can Island Creek coal lower the cost per 1000 pounds of steam?...

It's Precisioneered*

Washed coal stores better, handles better, and results in lower equipment maintenance costs.

* Everything that happens to a Precisioneered Coal at Island Creek is designed to make it do its job most efficiently, at the lowest possible cost. It starts at the mine face—with superior seams of eastern coal. It continues through the modern preparation plants where precision engineering techniques and strictest laboratory controls assure a product that will produce steam—in your equipment—at the lowest net cost per 1000 lbs. We'd welcome a chance to discuss the far-reaching engineering service and evaluation studies that are also part of Island Creek Precisioneering—and which can forecast in advance what can be done to lower net costs. Write. Or phone. No obligation, of course.

ISLAND CREEK
Precisioneered Coal

You can depend on Island Creek . . . a career company dedicated to coal

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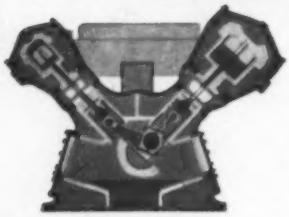
For more data circle 577 on Post Card

Will your next Y-type compressor have all of these

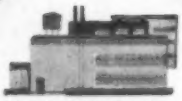
HIDDEN VALUES?



Frankly, it won't! Twenty-four of the values contribute to Worthington Y-type compressor performance. The other is fictitious—to see if you know enough about compressor quality to identify it. See page 138 for the *real* fictitious feature.

As you decide which 24 values are real, remember that they're not the obvious characteristics that show up on pressure gauges or price tables. They are true "values" that reveal themselves in your maintenance records ten years hence—when you find out that "those Worthington's are least expensive to run." Next time you specify a compressor, please see your local Worthington representative. Worthington Corporation, Compressor and Engine Division, Buffalo, N.Y. 36-9

WORTHINGTON



$1,000,000 ADDITION TO LABORATORY assures sound equipment designs based on actual research.

COMPOSITION TEST determines constituents of molten iron in each ladle before any casting is poured.

OPTIC COMPARATOR is used to check connecting rod bolt threads for uniform angles, lead and form.

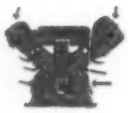
MAGNAFLUX AND MAGNAGLO inspections are widely used to expose surface imperfections.

PARCO-LUBRITING of critical wearing surfaces completely eliminates most start-up scuffing problems.

2000 CRAFTSMEN, these units built by same men who design and build large 5000 hp, 15,000 psi units.

COUNTERWEIGHTED CRANKSHAFT eliminates vibration and insures a smoother operation.

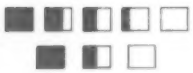
SELF-CLEANING OIL FILTER turns continuously to insure clean oil for pressure lubricating system.



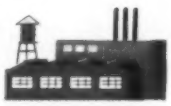
ACCESSIBILITY – valves, packing and main parts are easily observed and reached by operators.

FAST SHIPMENT– two-stage 100-125 psi units are continuously stocked items, for quick shipment.

WATER-COOLED CRANKCASE keeps oil and compressor running gear at proper temperature.



CAPACITY CONTROL by-pass unloading, cool-operating suction valve unloaders, 3 step or 5 step option.



INTEGRATED DIV. includes foundry, manufacturing, sales, service and engineering in one location.

DESTRUCTION TEST of complete compressor cylinders verifies engineers' design calculations.

ASME DESIGN INTERCOOLER of straight tube construction externally mounted, is readily accessible.

CHOICE OF DRIVE – Flange mounted, Multi-V belt or direct coupled with tapered shaft, easy mounting.

ARTICULATED CONNECTING ROD reduces crankshaft length, reduces weight and gives fewer parts.

FEATHER VALVE – industry's preferred compressor valve—is efficient, quiet, and low in maintenance.

SALES AND SERVICE INTEGRATION recognizes kinship of one to the other. One man administers both.

HONING of connecting rod crankpin and crosshead pin ends results in tighter fits, no loose shells.

PROFILOMETER inspection of highly finished parts assures easy break-in and long life.

ADJUSTABLE ROLLER MAIN BEARINGS feature low friction losses which help to extend compressor life.

PACKAGE UNIT shipped assembled—factory alignment unchanged and no field adjustment needed.

REMOVABLE DOWEL locks piston rod to crosshead—prevents turning due to loosened crosshead nut.

ULTRASONIC TEST – an advanced method of examining certain critical parts for internal quality.